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FRACTURES OF THE NECK OF THE FEMUR[1]

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INTRODUCTION

FRACTURE of the neck of the femur constituted a difficult therapeutic problem even in the hands of the most competent orthopedic surgeons, until the last decade. During that time, the problem of its treatment has been partly solved by new developments in roentgenologic technic (principally the use of "lateral" roentgenograms of the hip), and in surgical treatment by means of internal fixation (thanks to the invention of a new non-corrosive steel, used chiefly in the form of flanged nails and pins). Experience with these newer developments suggests that we must now apply a more accurate classification to fractures of the neck of the femur, partly as a guide to treatment and partly as a guide to prognosis. The end-results of treatment of fractures of the femoral neck, as reported in the literature (see Table I) vary considerably, due to the use of rather indefinite criteria in the diagnosis of bony union, and to the fact that the follow-up period has often been too brief, sometimes as short as one year. Careful study of end-results after an interval of five years would be of greater value, especially since a significant number of cases develop late and unexpected necrosing lesions of the head fragment or of the articular cartilages of the hip joint, thereby impairing previously "good" results.

Classification.—Fractures[2] of the femoral neck may be classified anatomically on various bases (3, 6, 29, 31). Magnuson (31) and others (5, 24, 29) have stressed that classification is important both for the selection of the method of treatment as well as for prognosis. In the past, certain single methods of treatment have been stressed, irrespective of the type of fracture. However, recent experience suggests that the type of fracture may be an important guide to the kind of treatment employed (28, 31); for example, a horizontal fracture of the femoral neck, in valgus position, may be treated by a Whitman abduction cast, while a vertical fracture must nearly always be treated by nailing.

A commonly used classification divides fractures of the femoral neck into intracapsular and extracapsular fractures; this is not satisfactory since many fractures of the femoral neck are both intra- and extracapsular at the same time; further, it is often impossible to ascertain roentgenologically the relationship of the fracture line to the capsule. (It is to be remembered that anteriorly the femoral neck is entirely intracapsular, while posteriorly

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

[2] Pathological fractures will not be considered in this article.

TABLE I.—INCIDENCE OF BONY UNION IN FRACTURES OF THE FEMORAL NECK AS REPORTED IN THE LITERATURE[1]

Date	Author	Type of Treatment	No. Cases	Time before End-result Determined (years)	Percentage of Cases Showing Bony Union	Percentage of Cases Showing Bony Union Based on *All* Cases Treated
1929	Am. Orthoped. Assn. Com.	Closed: Pts. over 60 years	201	1	30.4	
1930	Am. Orthoped. Assn. Com.	Closed: Pts. under 60 years	262	1	51.9	
1930	Am. Orthoped. Assn. Com.	Open: All ages	103	1	86.4	
1937	Albee	Bone graft	39		97.4	
1931	Apfelbach	Closed: Ambulatory cast	22		77.0 A	
1936	Böhler	Closed: Whitman	27	4	68.0	63.0
1936	Böhler	S.-P. Nail and open reduct.	25	4	65.0	52.0
1936	Böhler	S.-P. Nail and "blind" nailing	50	1/2	97.0	76.0
1935	Brewster	Martin's 2-screw	53		89.6	
1937	Caldwell	Moore's 3-pin	31		75.0	64.0
1931	Camitz	Summary from literature	903		61.9	
1937	Campbell	Bone pegging	36	2	71.0 B	55.0
1937	Campbell	S.-P. Nail	35	2	100.0 B	54.0
1938	Cleveland and Bosworth	Closed	50		46.5	
1935	Dickson	Open	9		77.0	
1935	Dickson	Closed	68		70.0	
1930	Groves	Closed	24		82.0	
1937	Harris	S.-P. Nail	50		72.0	
1934	Henderson	Closed	51		66.0	47.0
1934	Henderson	Open	24		75.0	
1934	Howard and Christophe	Closed	99	1	73.0	44.0
1936	Johansson	S.-P. Nail	117		95.0	85.0
1936	Key, A.	2-pin Method	29	2/3	58.0	45.0
1937	Kleinberg	Closed: Ambulatory cast	24		92.0	
1938	Leadbetter	All: summary from liter.	1057		68.0	
1938	Leadbetter	Closed	81		71.1 A	
1935	Lehmann	Open: summary from liter.	155		84.0	
1938	McMurray	Schanz osteotomy	27		100.0	
1936	Mensor and Dewey	Closed	50		0.0	
1937	Moore, A.	3-pin	42	2	96.0	70.0
1930	Reggio	Closed: Whitman	49		49.0	
1937	Schumm	Schanz osteotomy	13		100.0	
1931	Smith-Petersen	S.-P. Nail	24	2	75.0	62.0
1938	Smith-Petersen	S.-P. Nail	26	2	70.0	
1936	Thornton	Open	50		80.0	
1923	von Hubner	Closed	135		6.6	
1936	Watson-Jones	S.-P. Nail	35		91.0	
1936	Mitchell	Closed	10		90.0	
Percentage of Cases Showing Bony Union		Closed Methods:	0– 92%	average, 53.2%		mean, 70%
		Open Methods:	58–100%	average, 78%		mean, 80%
		All Methods		average, 65.6%		

[1] *Criteria of Union.*—*A.* "Bony trabeculations crossing the fracture line." *B.* "Complete consolidation and organization; obliteration of fracture line by reformation of lines of force." In all other reports the criteria were not specifically stated; some authors appear to base their diagnosis of *bony* union on the clinical function present; others are not specific concerning the roentgenologic criteria.

the distal one-third of the neck is extracapsular (9, 14).)

The most frequently used anatomical classification which is satisfactory is that which divides these fractures into *subcapital, transcervical,* and *cervicotrochanteric* (see Fig. 1). Subcapital fractures are completely intracapsular; transcervical fractures are frequently intracapsular; cervicotrochanteric fractures are usually extracapsular. This classification emphasizes the importance of the site of the fracture line; the nearer the fracture line lies to the femoral head the poorer is the nutrition of the head fragment.[3]

[3] There is no unanimity amongst writers in the literature (6, 14, 31, 35, 37, 41) as to the significance of the capsular attachments relative to the blood supply of the fracture zone, and, therefore, relative to bony union. Indeed, it is our opinion, based on a careful perusal of the literature, that bony union depends more on complete and thorough fixation of the fragments than on any other single factor such as capsular attachments alone. However, it would seem that late changes in the proximal fragment (aseptic necrosis of the femoral head, and so forth) depend largely upon the blood supply of this fragment.

We believe that fractures of the femoral neck should be subdivided on the basis of the direction of the fracture line as seen in the anteroposterior roentgenogram, since the downward weight of the body exerts a very unfavorable influence in relatively vertical fractures and a not unfavorable influence in horizontal fractures (29). A fracture line parallel to the longitudinal axis of the body is described as *vertical;* one roughly at right-angles to that plane as *horizontal,* and one in between the above two directions as *oblique* (see Fig. 1). A few fractures will not be linear, but rather *V*- or *L*-shaped; these should be classified according to the direction of the major limb. It is to be remembered that the fracture line is often oblique in the sagittal plane (as well as in the above mentioned vertical or cephalocaudad plane), the degree of obliquity being determinable only by lateral projections. Since such projections are not always made at the initial examination, and since introduction of this subdivision would render description unnecessarily complicated, we believe that this qualification should be dispensed with in a practical classification. However, the roentgenologist should always report this finding, when present, in the body of his report.

To be complete, a description of a fracture of the femoral neck should also include a notation as to whether or not it is impacted or separated, comminuted or simple, and whether the fragments lie in a varus, neutral, or valgus relationship to each other. When the shaft fragment is relatively high and lies beside the head fragment (bringing the angle of head and shaft to almost a right-angle), there is said to be a varus deformity; when the head is high, virtually resting upon the distal fragment, there is said to be a valgus deformity (see Fig. 2). Magnuson stresses the importance of separation of the fragments as being indicative of damage to the soft tissues, including the capsule.

In summary, therefore, fractures of the femoral neck should be divided according to *location* (into subcapital, transcervical, and cervicotrochanteric), and subdivided according to *direction* (vertical, oblique, and horizontal), according to relative *position* of the fragments (impacted or separated; varus, neutral, or valgus), and according to the condition of the fragments (comminuted or simple). Some of these points may be difficult to determine from the preliminary x-ray examination alone, but a review of the films made both before and *after* reduction will usually permit complete analysis and classification.

TECHNIC

For practical reasons, diagnostic technic may well be discussed under three headings: (1) before treatment; (2) during operation; (3) after operation and during the period of follow-up. The reason for this subdivision is that radiographic technics possible at one period are often quite impractical during another.

1. *Pre-operative Technic.*—Our routine examination consists of stereoscopic anteroposterior films of the pelvis made on a Bucky diaphragm with the patient's legs in as symmetrical a position as possible. It is frequently impossible to place the injured limb in the desired position of slight internal rotation, and it is often impossible to abduct it sufficiently for lateral projections. Indeed, lateral projections at this stage are often not essential. Our technic for the average 140-pound adult is: Position, anteroposterior; kv.p., 65; ma., 15; distance, 36 inches, and time, 10 seconds. Using 14 × 17 films, large cone, Potter-Bucky diaphragm, par speed screens, focal spot 2 mm. square or smaller.

2. *Operative Technic.*—Following manipulation and attempted reduction of the fragments by the orthopedic surgeon, an anteroposterior and lateral (infero-superior) projection is made to confirm alignment. (*Note.*—By "lateral projection" may be meant "supero-inferior" or "infero-superior," the cassette being inside and below the hip, or outside and above it, respectively. The supero-inferior projection is preferable, but surgical considera-

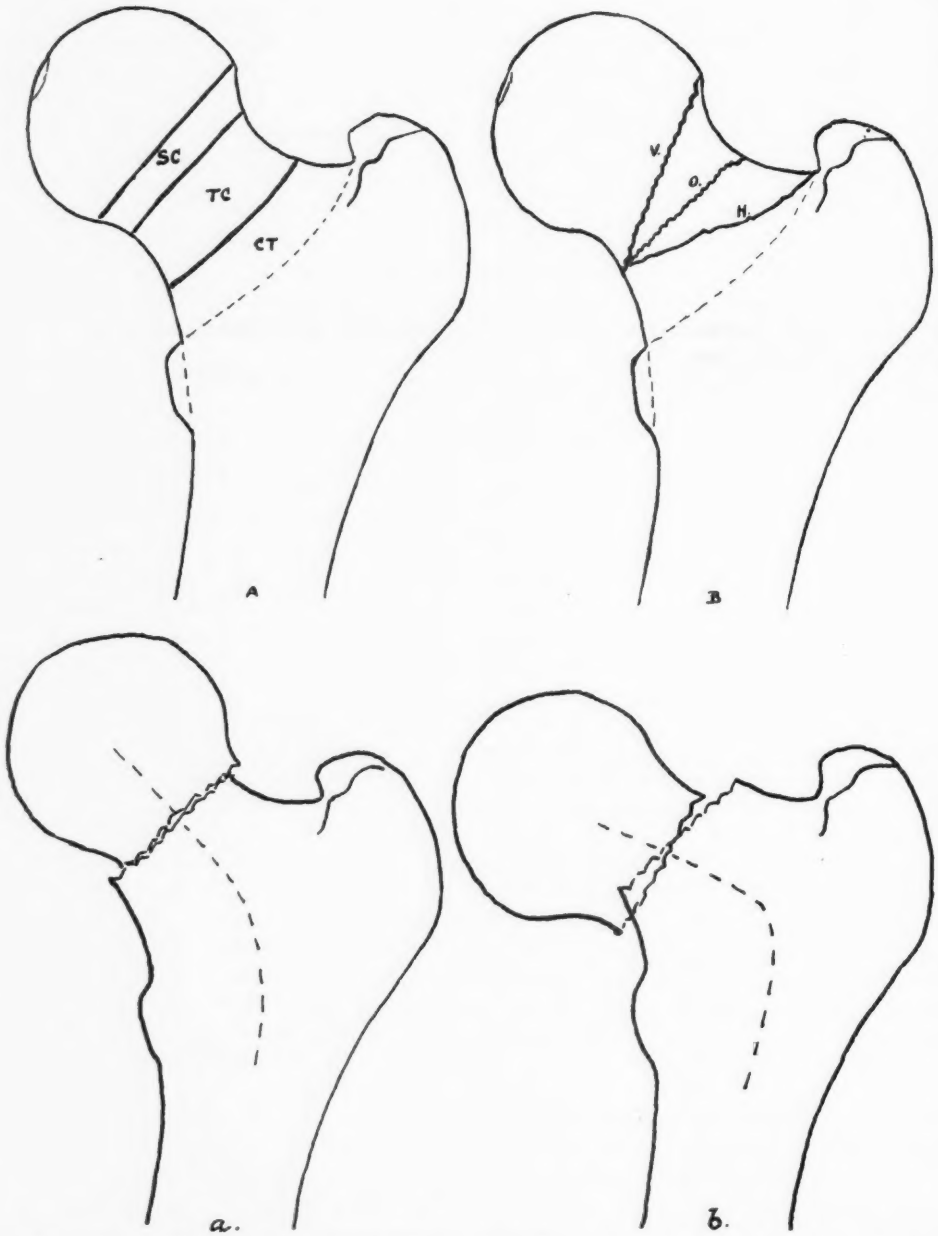


Fig. 1 (*above*). Diagram showing points used in classifying fractures of the femoral neck on an anatomical and "directional" basis. *A*, anatomical; *S.C.*, subcapital; *T.C.*, transcervical; *C.T.*, cervicotrochanteric. *B*, directional; *V*, vertical type of fracture; *O*, oblique type of fracture; *H*, horizontal type of fracture. (Note: The term "mid-cervical" would appear preferable to "transcervical" but the latter is well established in the literature. Similarly, the term "transverse" would appear more appropriate than "oblique," but this would cause confusion with "horizontal" and, therefore, the term "oblique" is used in this paper.)

Fig. 2 (*below*). Oblique transcervical fracture of the neck of the left femur, illustrating (*a*) valgus and (*b*) varus positions of the fragments.

tions often demand use of the infero-superior one. Following fixation, some authors obtain a "lateral" projection by abducting and flexing the leg to almost 90 degrees, and then making exposures of the neck with the equipment in the same position as for anteroposterior views.)

Our technic for the average adult is as follows: anteroposterior position, 45 kv.p., 10 ma., 25-inch distance, 10 seconds; lateral position, 55 kv.p., 10 ma., 25-inch distance, 10 seconds, using 8 × 10 films, small cone, par speed screens, portable unit. If desired, rapid processing may be done by using warm developer (1 minute at 85° F.). We do not, as a rule, employ fluoroscopic examination. Fluoroscopy, especially multiplane fluoroscopy, is useful with thin patients.

If reduction is satisfactory, the surgeon usually then inserts a guide wire or pin into the fragments. A second pair of films, anteroposterior and lateral, is then made. If these show satisfactory position, a non-corrosive flanged nail is partly introduced and a third pair of films is made. If the nail is in good direction and the head fragment is not rotated, introduction is completed and a final pair of films is made for permanent record.

3. *Post-operative Technic.*—At varying intervals, depending upon the type of fracture and the judgment of the attending orthopedist, anteroposterior and lateral projections are made to determine alignment and rotation, changes in the position of the nail, the amount of absorption along the line of fracture, the development of callus and bony union, and, finally, the appearance of the head fragment and the hip joint. Our technic for the average adult is as follows: anteroposterior position, 65 kv.p., 15 ma., 36-inch distance, 10 seconds (Bucky); in the lateral position, 65 kv.p., 15 ma., 30-inch distance, 5 seconds (non-Bucky).

Union and Non-union.—For clinical purposes, healing may be defined as the return of function, that is, painless weight-bearing and good mobility. For roentgenological purposes, healing may be defined as bony union. It is to be noted that bony union is not always accompanied by painless weight-bearing, because pain may be present on account of osteo-arthritic changes in the hip joint, changes in the head fragment due to aseptic necrosis, or to both causes (10, 24). In cases that have been treated by internal fixation, pain may also be due to projection of the nail beyond the cortex of the capital fragment into the hip joint. Union may occur in favorable cases as early as four months after the fracture; however, in other cases it may be delayed as long as twenty-four months.

Callus is formed into bone as the result of organization (40). It is important to distinguish between the two, since unorganized callus is malleable while organized callus (bone) is not (15, 19). Callus is said to be more readily converted into osseous material when partial or guarded weight-bearing has taken place (7, 14, 41). Unorganized callus may be distinguished from bony callus by its non-trabeculated structure, and by the fact that the fragments will not maintain their alignment under weight-bearing (except in the case of a horizontal fracture in a valgus position or in a fracture internally fixed).

Impaction of the fragments will frequently simulate callus, or even bony union, especially in those fractures which have been treated by internal fixation (21). Serial examination will be of help in some instances in differentiating between them, but even with this assistance the best type of roentgenographic technic is necessary to detect reformation of trabeculæ across the line of fracture. It is to be remembered that in fractures of the proximal half of the femoral neck "peri-osseous callus," the usual coarse x-ray evidence of beginning union is not seen. It is not known whether this is on account of lack of periosteum or of "osteogenetic tissue" around the major portion of the femoral neck (3, 7, 14, 37, 41). Lastly, it is to be noted that, in this connection, by *impaction* we mean "parallel surface" or "perfect apposition" impaction as distinguished

Fig. 3-*A*.

Fig. 3-*B*.

Fig. 3-*A*. D. B., male, aged 50 years. Oblique transcervical fracture of the left femur. In this case we erroneously diagnosed bony union by x-ray examination on Dec. 28, 1936, but the patient was subsequently shown at operation to have non-union.

Comment: This case illustrates the ease with which bony union may be erroneously interpreted from the roentgenograms, especially when one does not employ definite criteria for making such interpretation. We thought that we could see bony trabeculæ extending across a considerable portion of the line of fracture at the examination of Dec. 28, 1936, but did not realize that this finding alone is insufficient to warrant a positive interpretation of beginning union, since it may be simulated by superimposition of the fragments. Our present criteria (obliteration of the line of fracture, reformation of cancellous tissue across the line of fracture, and maintenance of position after weight-bearing) would have prevented our making a positive x-ray diagnosis of early union.

Description of roentgenograms—April 15, 1936: Oblique transcervical fracture of the left femur, following reduction. June 8, 1936, through Oct. 6, 1936: Behavior of fracture following internal fixation by four metal pins (*lateral* projection showed nail in satisfactory position). Dec. 28, 1936 (eight months after

fracture): Apparent bony union along portion of the line of fracture. March 1, 1937: Apparent reformation of a few of the lines of force between the fragments. Clinically the patient had painful weight-bearing and the orthopedic surgeon (Dr. Soto-Hall) did not believe union was present (see Figure 1-*B*).

Fig. 3-*B*. Continuation of the case illustrated in Figure 1-*A*. Oblique transcervical fracture of the left femur, showing late bony union following internal fixation. Present clinical status: good function; no pain.

Description of roentgenograms—March 15, 1937: Film made immediately following open operation and discovery of non-union, showing Smith-Petersen nail in position (*lateral* projection showed nail in satisfactory position). May 15, 1937: Progress examination showing satisfactory position but no union. Oct. 8, 1937 (seven months following insertion of Smith-Petersen nail): Definite bony union between the fragments, evidenced by obliteration of line of fracture, reformation of trabeculations across fracture line, and maintenance of position following weight-bearing. Feb. 8, 1937: Firm bony union confirmed. (Case reported through the courtesy of Dr. Ralph Soto-Hall.)

from ordinary angular or marginal impaction. This deceptive parallel surface impaction is said to occur in only 10 per cent of fractures of the femoral neck (21).

Criteria for the Diagnosis of Healing.—Since the roentgenologic evidence of bony union is accepted as the criterion of healing for almost all fractures, it would seem superfluous to do more than outline the standard points upon which an x-ray diagnosis of bony union is based. However, several writers on the subject of fractures of the femoral neck indicate that they do not regard the x-ray evidence of union as the important criterion of healing (7, 17, 38, 45). One of the reasons for this is dissatisfaction with the roentgenologist's ability to diagnose such union with certainty. Smith-Petersen[4] has observed that in some of his early nailed cases a poor end-result was obtained because incorrect roentgen diagnosis of bony union led to withdrawal of the nail when the fragments were still ununited. We regard the following signs as important for the roentgen diagnosis of bony union: (1) disappearance of the line of fracture; (2) formation of bony trabeculæ across the line of fracture, and, ultimately, reformation of the "lines of force"; (3) maintenance of relative position of the fragments after a trial of weight-bearing, and (4) occasionally, formation of bony bridges between the fragments, outside the boundaries of the neck. Under ordinary circumstances the first three signs should be present in a given case before a diagnosis of union is made.

Non-union is indicated by persistence of the fracture line (or reappearance of the fracture line if previously obliterated by impaction); increased density of the fracture surfaces; absorption of a portion of the femoral neck; lack of maintenance of alignment between the fragments.

Fibrous union is virtually not diagnosable by roentgen examination alone. It would be suggested by the maintenance of fixed relative position of the fragments, with the leg in different positions, such as adduction and abduction, or after a trial of weight-bearing; but its positive diagnosis requires surgical exploration.

INFLUENCE OF CERTAIN FACTORS ON THE X-RAY EVIDENCE OF HEALING

Technic of Examination.—It is important to use a fine focal-spot tube (2 mm. square or less), intensifying screens giving a perfect contact and, in some cases, multiple projections to diagnose bony union. Stereoscopic anteroposterior films are a minimum; oblique and lateral projections are often valuable, although bone detail is apt to be too poor in lateral projections to permit positive opinions concerning trabeculations across the fracture line. Incorrect exposure or development may render it impossible to ascertain whether or not callus or new trabeculations are present. If examinations are made with the leg in abduction and then adduction, the pelvis must be securely fixed and the leg and foot kept in the neutral or non-rotated position, at each examination.

[4] Personal communication.

Portable equipment is usually not satisfactory for making examinations to determine the presence of union.

may appear to be continuous. The fragments are more apt to remain in apposition if the fracture is horizontal, rather than

TABLE II.—SUMMARY OF PRESENT ORTHOPEDIC OPINIONS CONCERNING THE RADIOLOGICAL ASPECTS OF UNION IN FRACTURES OF THE FEMORAL NECK[2]

	Yes	No	Qualified
Is the x-ray evidence of bony union superior to the clinical?	11	4	2
Can x-rays be used to determine whether or not there is sufficient callus for weight-bearing?	7	10	
Can x-rays be used to differentiate impaction from bony union?	12	5	
The x-ray examination necessary for the determination of bony union is:			
Anteroposterior and lateral views	14		
Anteroposterior views in abduction and adduction	7		
Anteroposterior view after trial of weight-bearing	8		
Anteroposterior views one year after fracture	5		
The x-ray signs of bony union are:			
Trabeculations extending across the fracture line	13		
Reformation of the lines of force	11		
Maintenance of alignment in abduction and adduction	8		
Increased density along the line of fracture	3		

[2] The following orthopedists were kind enough to reply to our questionnaire: F. H. Albee, M.D., F. C. Bost, M.D., W. C. Campbell, M.D., R. K. Ghormley, M.D., J. M. Hitzrot, M.D., J. A. Key, M.D., D. King, M.D., P. Lewin, M.D., A. T. Moore, M.D., F. M. McKeever, M.D., C. R. Murray, M.D., H. W. Orr, M.D., D. B. Phemister, M.D., A. R. Shands, Jr., M.D., V. A. Ruth, M.D., R. Soto-Hall, M.D., M. N. Smith-Petersen, M.D.

TABLE III.—SUMMARY OF CASES OF FRACTURE OF THE NECK OF THE FEMUR SEEN ON THE STANFORD UNIVERSITY SERVICE AT THE SAN FRANCISCO HOSPITAL FROM 1928 TO 1936

(Total Number of Cases 102)

Left Hip:	55%	Females:	52%
Right Hip:	45%	Males:	48%

Age Distribution

0–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90
2	2	4	16	25	27	20	6

Youngest:	7	Age 60 or below:	48%
Mean:	61	Age above 60:	52%
Oldest:	88		

Classification

By region:

Sub-capital	14%
Transcervical	73%
Cervicotrochanteric	13%

By direction of the fracture line as seen in the anteroposterior films:

Oblique	63%
Vertical	19%
Horizontal	18%

By combination of the last two features:

	Oblique	Horizontal	Vertical
Sub-capital	41%	9%	50%
Transcervical	65%	20%	15%
Cervicotrochanteric	73%	18%	9%

Type of Fracture.—The linear *direction* of the fracture line is more important than its anatomical *location* as far as the x-ray evidence of healing is concerned (6, 29, 31, 35). If the fracture line runs obliquely from front to back, it may be impossible to state whether or not there are new bony trabeculations crossing it, since the trabeculations of the two fragments overlap and

vertical, and, in addition, upon weight-bearing they tend to become impacted. Therefore, in the horizontal type of fracture the fracture line is apt to be less evident; following reduction it may show a slight increase in density due to partial impaction, which must be carefully differentiated from early callus. In vertical fractures the fragments tend to become

separated; there is usually some absorption of the neck; when callus develops it may become quite dense before organization occurs and the new lines of force may be quite asymmetrical, in contrast with those of the uninjured leg.

Fig. 4. L. D., female, 53 years of age (60 at the time of report). Oblique transcervical fracture of right femur. This case ultimately united by formation of a bony bridge on the mesial aspect of the fragments. Clinically, the patient is able to get about with the aid of two crutches; there is about two inches of shortening; walking is not painful but the difficulty of getting about is such that she walks very little.

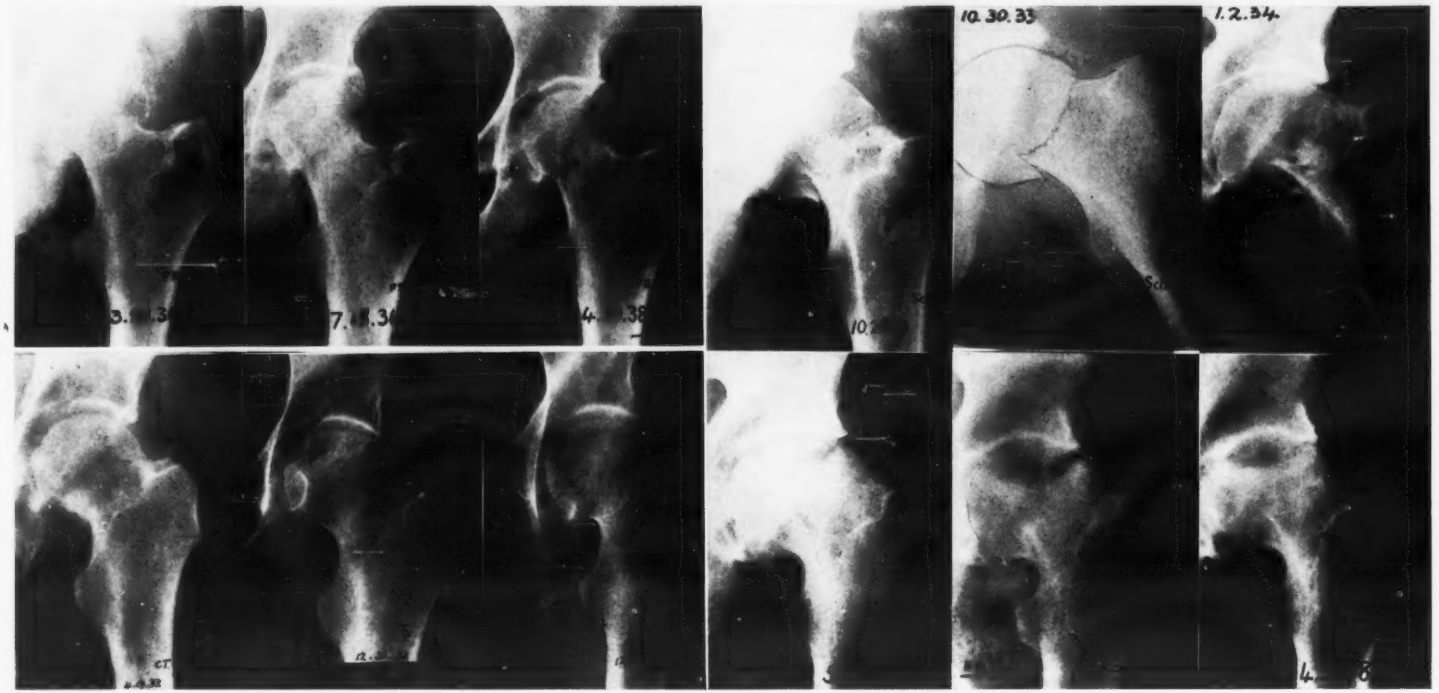
Comment: This case illustrates the difficulty of diagnosing firm bony union from the roentgenograms alone, the examination of Dec. 14, 1932 (five months after fracture) being interpreted by one radiologist as showing bony union; subsequent examination showed this to be incorrect.

Description of roentgenograms—July 7, 1932: Oblique transcervical fracture of right femur, with moderate shortening and rotation of distal fragment. July 9, 1932: Varus deformity following reduction. Oct. 19, 1932: Marked varus deformity; no bony union. Dec. 14, 1932: Insertion of metallic wires and Smith-Petersen nail (*lateral* projection showed nail in satisfactory position). Jan. 18, 1933: Slight displacement of fragments in spite of presence of Smith-Petersen nail. Aug. 29, 1933: Further upward displacement of distal fragment, so that it rests against the ilium. March 30, 1938: Union of fragments by short bony bridge between lesser trochanter and head. Absorption and erosion of mesial end of nail; ankylosis of the distal fragment to the lateral aspect of the ilium, just above the acetabulum. Atrophy and absorption of the head; no union across fracture surfaces proper.

Type of Treatment.—The x-ray evidence of healing (new trabeculations and lines of force) may be obscured by a heavy plaster splint. Internal fixation maintains the alignment of the fragments and will often support weight-bearing; therefore, reliance on good alignment and maintenance of position becomes useless except in those rare cases (26) in which the nail slips partly or entirely out of the head fragment.

CLINICAL IMPORTANCE OF THE X-RAY EVIDENCE OF HEALING

The x-ray evidence of healing is important (*a*) in order to determine the time at



Figs. 5 and 6. Fig. 7.

Fig. 5 (*upper left*). F. S., female, 58 years of age. Oblique subcapital fracture of the left femur, without displacement or significant separation of the fragments. Clinically, the patient walks without trouble.

Comment: This case illustrates very well the criteria for the roentgen diagnosis of union. One assumes that bony union occurred very early in this case because of the relatively impacted, valgus position of the fragments.

Description of roentgenograms—March 20, 1936: Oblique subcapital fracture of the left femur, with slight impaction, in excellent position. July 18, 1936: Partial obliteration of line of fracture with extensive trabeculations across this line; bony union in progress. April 30, 1938: Firm bony union evident two years later.

Fig. 6 (*lower left*). C. T., female, 46 years of age. Oblique transcervical fracture of left femur, with apparent impaction. The patient's hip was clinically well three years after the fracture, when she died of other causes.

Comment: This case illustrates the difficulty of differentiating impaction from bony union, since, in the absence of a knowledge of the time element, it would be quite easy to make a roentgen diagnosis of apparent union at the examination of April 19, 1932.

Description of roentgenograms—April 19, 1932: Oblique transcervical fracture; slight varus position; probable impaction. Dec. 30, 1932: Bony union, demonstrated by obliteration of the line of fracture, reformation of trabeculations, and lines of force and maintenance of alignment following weight-bearing. Dec. 12, 1933: Good bony union; no evidence of aseptic necrosis.

Fig. 7 (*right*). S., male, 53 years of age. Oblique transcervical fracture of left femur. This case showed good bony union but late necrosis of a portion of the proximal fragment. Clinically, the patient got along well until early in 1937, when walking became painful and he was finally confined to bed. Following removal of the necrosed portion of the proximal fragment by Dr. Donald King, function returned and he now walks moderately well.

Comment: This case presents no difficulty in the roentgen diagnosis of bony union but does reveal unexpected aseptic necrosis of the proximal fragment, three years following the fracture, and also demonstrates that painful weight-bearing may be due to causes other than non-union (in this case to a combination of aseptic necrosis and traumatic arthritis).

Description of roentgenograms—Oct. 28, 1933: Oblique transcervical fracture of the left femur, in varus position, with partial impaction of the inferior spicule of the distal fragment and the head fragment. Oct. 30, 1933, to Jan. 2, 1934: Moderate absorption along the line of fracture; no union. May 8, 1937: Good bony union; sequestration of a large portion of the head fragment along the zone of weight-bearing. Nov. 19, 1937: The large sequestered fragment has been removed. April 30, 1938: Further sclerosis or eburnation of the superior surface of the head fragment; atrophy and absorption of articular cartilage in the acetabulum.

which weight-bearing may be permitted; (*b*) in order to determine whether operative measures are indicated, that is, when non-union is present, and (*c*) in order to evaluate the end-result. Some surgeons and orthopedists rely on x-ray evidence of bony union as the determining factor in permitting partial or full weight-bearing (2, 5, 7, 21, 22, 28, 41, and 46). On the other hand, many prefer to rely on an arbitrary time interval of from two weeks to six months following internal fixation for such weight-bearing (3, 4, 6, 10, 12, 19, 27, 29, 31, 35, 43, and 45).

Personally, we have found, from a review of our own x-ray reports, that we have made some interpretations of bony union when subsequent events showed such was not present (see Fig. 3). Others (29, 45) have also commented on this not uncommon error. Therefore, we believe that great caution must be used in making an x-ray diagnosis of bony union as a guide to treatment during the first 12 months following fracture. However, based on the criteria we have outlined, we believe that such a diagnosis *can* be made, and that it becomes of increasing accuracy with the passage of months, so that after 24 months it serves as a very important criterion of final healing (34).

INCIDENCE OF BONY UNION IN FRACTURE OF THE FEMORAL NECK

In Table I are found the statistics from 28 different authors on the percentage of cases of bony union in fractures of the femoral neck.

We have summarized these reports, omitting those which were a compilation of results reported by other authors or those elicited by the American Orthopedic Association's questionnaire. It will be noted that the percentage of cases reported as showing bony union varies from 0 to 100 the average being 65 per cent. Only three of these reports indicate the criteria employed in the x-ray diagnosis of bony union, and we believe that for comparative purposes most of the figures given are of doubtful value because of the following reasons: (1) the fractures have been classified on miscellaneous and often incomplete bases; (2) the types of treatment used have differed radically; (3) the criteria for making the diagnosis of bony union have varied considerably, even when based on the x-ray examination (38, 46), and (4) the percentage of cases of bony union has been determined by varying methods—for example, on a basis of all cases admitted to the service, on all living cases, on all cases followed for a stated period, or on all cases which could be traced. The conclusion which we wish to draw from this material is that definite criteria for the x-ray diagnosis of bony union should be agreed upon before reporting end-results.

Authors' Questionnaire.—To ascertain the current opinion of orthopedic surgeons in this country regarding the evidence of union in fractures of the neck of the femur, the authors sent a questionnaire to several orthopedists who had written extensively on the subject or who were members of the

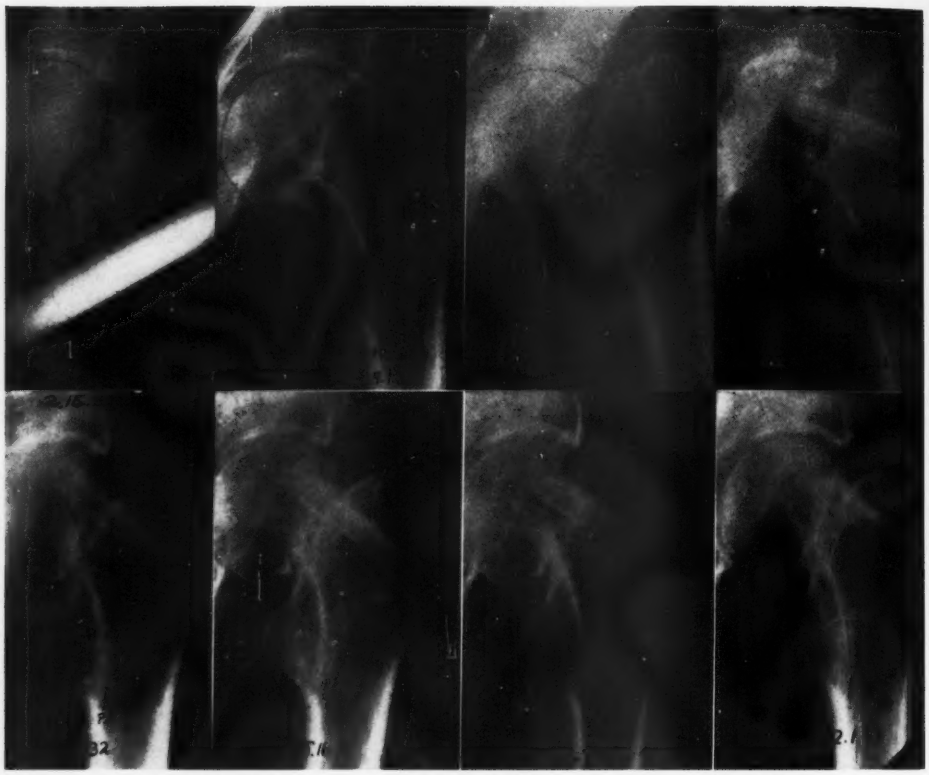


Fig. 8. P. P., male, aged 44 years. Vertical transcervical fracture of the left femur. Clinically the patient is able to walk with only slight pain and a slight limp.

Comment: The roentgenograms of this case illustrate all the criteria for the roentgenologic diagnosis of bony union.

Description of roentgenograms—July 26, 1931: Vertical transcervical fracture of the left femur in moderate varus position. (The fracture is partly subcapital but since the major portion of it is transcervical, it falls in the latter group.) Sept. 1, 1931: Moderate absorption along the line of fracture. Oct. 5, 1931: Further absorption. Nov. 24, 1931: Internal fixation by full-thickness bone graft. Feb. 18, 1932, and May 16, 1932: Position satisfactory; no union. Aug. 24, 1932: Almost complete obliteration of line of fracture; trabeculations crossing line of fracture. Union in progress. Feb. 1, 1933: Firm bony union; lines of force reformed; no shift of fragments following weight-bearing; fragments of similar density (no evidence of necrosis of proximal fragment).

Committee of the American Orthopedic Association on End-results in Fractures of the Femoral Neck. The answers of these authors are summarized in Table II.

The opinions are fairly evenly divided as to the use of radiographs to determine whether or not there is sufficient callus for weight-bearing. Surprisingly, the majority believe that impaction may usually be differentiated roentgenologically from bony union; personally, we believe this is extremely difficult in most cases of true impaction. Many of these answers were qualified in an interesting manner, but lack of space prohibits detailed consideration of these qualifying statements.

Findings Observed in the Authors' Radiological Experience.—Through the courtesy of the surgical and orthopedic divisions of the Stanford University Service at the San Francisco Hospital, we have reviewed 102 cases of fractures of the femoral neck seen during the years 1928 to 1936. The findings are summarized in Tables III and IV.

In this group of cases, many of the rou-

Fig. 9. M. A., female, seven years of age. Oblique cervicotrochanteric fracture of the right femur. Clinically the patient walks well, without pain.

Comment: This case illustrates a typical fracture of the femoral neck as seen in children.

Description of roentgenograms—July 15, 1936: Oblique cervicotrochanteric fracture, following reduction, in good position (confirmed by lateral projections). Aug. 27, 1936: Moderate displacement of distal fragment, with varus deformity. Sept. 17, 1936: No evidence of union. Jan. 8, 1937: Partial obliteration and increased density of the line of fracture indicative of early callus formation. April 30, 1937: Bony union, indicated by obliteration of the line of fracture, reformation of trabeculations and lines of force across the line of fracture, and maintenance of alignment following weight-bearing. Oct. 15, 1937: Good bony union; fragments of same density; no evidence of aseptic necrosis in capital fragment.

tine x-ray examinations were interpreted by one of the resident house officers in radiology; a few of them were read by ourselves or by one of the other visiting radiologists. Irrespective of experience, there were several cases in which, from the x-ray appearance alone, we made an interpretation of bony union when such was subsequently found not to be present. In many cases we were unable to diagnose the exact type of fracture from the initial examination, owing to rotation and displacement of one or both fragments.

We had hoped to study a sufficient number of united fractures in order to determine the relationship between the different types of fracture and the subsequent development of bony union in this series, but were unable to accumulate sufficient material to warrant statistical analysis. The reasons for this may be seen in Table IV. However, a small number of cases could be followed for periods up to as long as eight years; we present the details concerning some of these cases in the legends accompanying the reproductions, in order to illustrate some of the above discussed points.

SUMMARY

The x-ray evidence of bony union is not closely correlated with the clinical evidence of healing, in fractures of the femoral neck. This is due to the use of indefinite

criteria for the x-ray diagnosis of union and to varying clinical criteria of healing.

In order to discuss fractures of the femoral neck, it is important to classify them on both an anatomic and a directional basis, since the location and direction of the fracture have important relations to healing. We believe that they should be divided into subcapital, transcervical, and cervicotrochanteric fractures, and into vertical, oblique, and horizontal sub-types.

The criteria for the roentgen diagnosis of bony union are: disappearance of the fracture line; formation of trabeculations across the line of fracture and reformation of the "lines of force"; maintenance of alignment of the fragments, and, occasionally, formation of a bony bridge outside the boundaries of the neck.

The x-ray diagnosis of bony union is important clinically because (1) it is often used as an indication for the time at which weight-bearing may be permitted; (2) the absence of union is used as an indication for operative intervention, and (3) the end-result of treatment may best be determined by such finding.

The end-results of treatment of fractures of the femoral neck reported in the literature are of little value for comparative purposes because the criteria for the diagnosis of union have been more subjective than objective, and because many of the cases have been followed for relatively short periods of time (that is, less than two years).

Except under exacting circumstances, with excellent technic and experienced interpretation, we do not believe that the x-ray evidence of bony union is superior to the clinical, since an appearance of bony union may often be simulated in the roentgenogram.

Unless good roentgenograms and experienced roentgenologic interpretation are available, the x-ray evidence of bony union should not be relied on to determine whether or not there is sufficient bony healing present for weight-bearing. The answer to this particular phase of the problem lies in the future: it may be deduced partly from the type of fracture, the position of the fragments following reduction, and the type of treatment.

The differentiation of impaction from early callus formation, especially after internal fixation, is extremely difficult by roentgenologic methods.

Increased density of the fracture line is frequently a deceptive finding and is of value only as an indication of callus when previous or serial examination has revealed a separation of the fragments.

TABLE IV.—CLINICAL COURSE AND FOLLOW-UP OF 102 CASES

	No. Cases	Bony Union Cases; Films Traced over One Year
Total No. Cases Deceased:		
Expired in less than one month	22	0
Expired in from one month to one year	15	0
Expired in from one year to nine years	17	3
Expired at time unknown—outside of hospital	9	2
Total Deceased	63	5
Total No. Cases Living:	39	
Transferred to private institutions	6	0
Moved to other towns	7	1
Cases non-traceable at present date	12	4
Traced but refused to return for check-up	4	2
Under survey	10	7
Followed less than one year by x-ray examination	85	0
Followed one to two years by x-ray examination	7	4
Followed over two years by x-ray examination	8	7

CONCLUSIONS

1. The x-ray evidence of healing of fractures of the femoral neck is based upon four criteria: (1) disappearance of the

fracture line; (2) formation of trabeculations across the line of fracture and reformation of the lines of force; (3) maintenance of alignment between the fragments after a trial of weight-bearing, and (4) occasionally, the formation of a bony bridge between the fragments.

2. The x-ray evidence of bony union is more reliable as a means of evaluating the end-result than of ascertaining the time at which it is safe to resume weight-bearing.

3. The discrepancy between various end-results reported in the literature, and the divergence of current surgical opinions as to the most reliable method of deciding the presence of union appear to be due in no small part to the fact that, in the past, x-ray interpretations of union have often been incorrect.

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DISCUSSION

J. HUBER WAGNER, M.D. (Pittsburgh, Pa.): I came here to discuss this paper as a general surgeon doing bone and joint surgery. I do some orthopedic surgery and when your speaker referred to me as an orthopedic surgeon, I thought it proper to correct the statement.

The major part of this work, I believe, is being done by the general surgeon and the term "orthopedic surgeon," I think, is used a little too often in reference to the treatment of fractures. If we look up the term and realize its meaning, the term "bone and joint or traumatic surgeon," in the future might be a little better usage.

As I said, I came to discuss this paper as a surgeon rather than as a roentgenologist. The paper is an interesting one and I believe that it will contribute much to our knowledge of fractures of the femur. It should be read generally, not alone by the radiologists but, more particularly, by the surgeons doing this type of work. The paper in itself, when read in its entirety, is a most excellent one—as good a one as I have ever had the pleasure of reading.

Referring to the subject, "Diagnosis of Union from the Roentgenologist's Point of View," I would say that, in looking at these slides, there are many interesting points I should like to discuss personally with the author, when time permits. A few years ago in Boston, Dr. Kellogg Speed gave his excellent paper on "The Unsolved Fracture," having to do with fractures of the neck of the femur. It is interesting to note how much this has stimulated not only roentgenologists but surgeons in general to get better results in this type of case.

Briefly, these patients were divided into three classes; 33 per cent who got well by the Whitman method; 33 per cent who might or might not get well, and then the 33 per cent who died regardless of what type of treatment they had.

To Smith-Petersen belongs the credit of stimulating the work of open reduction and anatomical re-position of the fragments with fixation. Since his work and publications there has been a tremendous increase in the number of patients who have secured union, so that we feel now the proper procedure is not one of conservative fixation by casting, but one of so-called "open reduction."

The roentgenologist can and does aid the surgeon greatly if the surgeon can be assured of the lines of fracture, as has been brought out by the author. To this end, I believe, as he has stated, the most essential point is to get the exact plane of the fracture in mind. This can be done to a certain degree by stereoscopic anteroposterior views, but better if a lateral is taken, either by the use of the curved

cassette, moving the uninjured leg out of the way and leaving the injured leg as it is, or by using a straight cassette and shooting from below up, so to speak. If the line of fracture can be determined in the anteroposterior view, then if the central ray can be shot through that plane, one has a better film with which to deal and can proceed properly. It is our endeavor to secure that knowledge before we attempt the reduction of a fracture. With that knowledge, we can nail the majority of these hips. We fix them, I should say, because I prefer to use the wood screw that has been used by Brewster, of New Orleans, as I feel it gives a better fixation than the Smith-Petersen nail. This is done by the help of the radiologist.

We use the Ledbetter method of reduction, having first determined the maneuvers we want to make, and then when we believe we have a reduction, we again take an anteroposterior film. A lateral view can also be taken at this time by again moving the uninjured leg out of the way (it is not our practice to do this, however), and then we proceed to the fixation or screwing. After it is fixed we do not move the patient much at that time, but two days later we take lateral and stereoscopic anteroposterior views to see the position of the fragments. If we have them in a satisfactory position and a proper radiological record is made, we can, in the future, by taking check x-rays in the various planes as indicated, determine the progress of union.

I believe that in the past, until this interest had been stimulated, the x-ray man usually was interested in gastric lesions, tumors, now and then x-rays of the lungs and heart. He had been a little prone to use some of his older equipment, because it ran in his mind, "Oh, that is a bone case —we will just take this old intensifying screen and give him the film and let it go at that." The bone surgeon, thinking the x-ray man's diagnosis was all right, many times was satisfied with a film that was not right. To-day, with our interest stimulated, we cannot be too careful as to the technic and material used in taking these films. The Bucky diaphragm has been a gread aid. Although I have had no experience with it, I am now told that the new Lysholm grid can be used at the operating table with good effect. One has to employ the fine points of technic to get the detail of the bone, for a careful diagnosis. This is especially true, as has been brought out by the author, in those vertical fractures which are oblique and in which, when reduced, one fragment overlies the other. Whether they are fixed in the cast or fixed by a pin, an anteroposterior view alone will give the impression that the trabeculations have gone past the line of fracture, whereas really they only overlap and a false impression is given. Hence, as I said before, I still feel the proper interpretation of the line of fracture prior to the reduction is the essential thing.

In these cases, as to the re-appearance of the lines of force, I find in my experience that they come very late. That is a thing that sometimes only develops two years or so later, after excessive use of the leg. From the surgeon's point of view, the reduction of these cases sometimes is difficult. If non-union occurs, it is mostly because there has not been a re-position of the fragments and a *proper fixation*. This bone will unite just the same as any other bone if given the opportunity.

In conclusion, I again want to stress the point that I believe this paper has more meat in it than the author had time to present here.

As to the criteria of bony union, one must not only consider the symptomatic union, that is, a patient who can walk and bear weight without pain, but by having previous x-rays showing the lines of fracture, and later check x-rays taken in the same planes as the previous ones showing complete trabeculation, loss of fracture line, and the beginning or formation of lines of force, then and then only can one definitely diagnose radiologically a bony union.

LEO G. RIGLER, M.D. (Minneapolis, Minn.): Speaking of Dr. Garland's excellent paper, he raised one question which

has bothered most of us a great deal, and I thought I might be able to clarify it a little by reference to a recent paper by R. Watson-Jones. The question Dr. Garland raised is why we get aseptic necrosis of the head in cases in which good bony union of the femoral neck has been achieved.

If we accept the thesis which Watson-Jones has advanced and which I think has been elaborated by many others before, the whole problem is a problem of ischemia and hyperemia and, I think, is easily explained. Furthermore, it has a good deal of bearing on this question of whether or not it is so important to have re-position and perfect position or whether the vital importance is to get perfect immobilization.

It has been shown clearly that, with hyperemia, decalcification of bone occurs and replacing of bone by fibrous tissue is likely to take place. The contrary is true of ischemia. With ischemia we get aseptic necrosis.

Now in our minds in the past we have been greatly influenced by the idea that non-union in fractures of the femur was likely to be due to disturbance of circulation. According to the work that they have done—and certainly it is borne out by clinical experience—disturbance of circulation is likely to produce an aseptic necrosis of the femoral head but have little or nothing to do with non-union.

If hyperemia produces replacement with fibrous tissue, then it seems obvious that the non-union is much more likely to be due to motion between the fragments, which would have little or nothing to do with the development of an aseptic necrosis of the femoral head; the latter might well be due to the disturbance of the circulation of the head from the original trauma.

So that it is perfectly reasonable to have a case in which you get aseptic necrosis of the femoral head and still have perfect union of the neck, because immobilization has been accomplished during the early stages of the fracture.

DR. GARLAND (*closing*): The various points brought out by Dr. Wagner are well taken. Permit me to remind you that lateral projections were made in all of the cases illustrated but were not always reproduced, either because they were technically poor or because they were not essential to illustrate the points under discussion. In the Scientific Exhibit, those who are interested may see a series of roentgenograms illustrating our technic at the present time, as used in conjunction with the orthopedic surgeons at Saint Joseph's Hospital in San Francisco.

Concerning the appearance of the lines of force, I cannot agree with Dr. Wagner. We have seen these lines reappear as early as eighteen months after fracture, but, on the other hand, have failed to see them in some cases after a period as long as five years (bony union having taken place in both cases).

Concerning Dr. Chamberlain's[1] comments, it should be remarked that the paper did not deal with the *proper* treatment of fractures of the femoral neck, but just with the question of the diagnosis of bony union. Nevertheless, I agree with his points concerning reasonably good reduction of the fragments.

I wish to thank Dr. Rigler for his remarks on aseptic necrosis of the femoral head.

[1] Not returned to the Editor for publication.

ESTROGENIC MAMMARY CANCER IN THE RAT[1,2]

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INTRODUCTION

MAMMARY cancer in susceptible strains of mice treated with various estrogenic compounds has been reported in a series of articles, beginning with that of Lacassagne in 1932 and followed by contributions by Bonser, by Burrows, by Cramer and Horning, by Loeb and his associates, and by Gardner, Smith, Allen, and Strong. In all, 139 mice including 103 males developed cancer. The exact number of cancers resulting from estrin administration in female mice in these experiments cannot be stated (it was less than 36), because inbred strains of mice in which the females spontaneously develop mammary carcinoma were used. In highly susceptible strains, Cramer and Horning and Gardner and others noticed a decrease rather than an increase in the incidence of cancer in females. Cancer was not obtained in non-susceptible strains. These experiments confirm the earlier work of Loeb in 1919, Cori in 1927, and Murray in 1928. These workers demonstrated by castration in females and ovarian transplants in males of susceptible strains that an ovarian secretion was necessary to attain the physiologic threshold in cases in which susceptibility to carcinoma became manifest in the mammary gland. The more recent experiments with estrogen cited above indicate this to be the specific ovarian hormone concerned in the development of mammary carcinoma in susceptible strains in mice. A variety of estrogens were used,[3] usually estrone benzoate. The amount of estrogen was ten or more times the physiologic dose (300 to 500 international units weekly). Administration was begun within from 30 to 40 days after birth, and cancer obtained in from 210 to 300 days.

In attempting to correlate these experiments in mice with what we know about cancer in the human, numerous drawbacks are apparent. In the first place, inbred strains of mice were used. Obviously there is no such brother-to-sister breeding in the human. Significant results were obtained on males and not females. There are species differences among mammals in endocrine response, and similar experiments have not been performed on the rat, rabbit, or monkey. McEuen and also Emge and Murphy failed to get mammary cancer in the rat with estrogen alone, and Lacassagne failed to produce pathologic changes similar to those seen in mice with high and prolonged doses of estrogens in rabbits. Zuckerman failed to note significant changes in the mammary glands of monkeys after two years of high daily doses of estrogens. Moreover, in the mice treated, the doses, which were abnormally high (more than ten times normal), failed to overcome genetic differences, and the estimated time required for the appearance of the cancer was nearly the entire lifetime of the animal. The method of dosage—local applications or injections once or twice weekly—was also unphysiologic, since in the normal animal a continuous secretion of the ovarian hormone over a period of days occurs. Although various methods of administering estrogen were used—such

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

[2] Aided by a grant from the Anna Fuller Fund.

[3] Other estrogens used were—ketohydroxyestrin, equiline and equilenine benzoate, hydroxy and dihydroxyestrin.

as skin application and injection in oil—no attempt was made to provide for continuous absorption.

In the author's opinion, the experiments reviewed (Table I) which were done on a single species of mammal using inbred strains and unphysiologic methods of dosage do not permit reliable deductions in regard to human mammary cancer. For this reason a new series of experiments employing a stock strain of Wistar albino rats in which no spontaneous cancers had been observed over a period of four years, in a colony of over 2,000 animals, was undertaken. The object was to gain, if possible, a further insight into the relation of estrogen to mammary cancer, and, if successful, to apply these results by experimental methods to rabbits and monkeys as well as rats.

The author (Geschickter, 1939) has found that mammary cancer can be induced in the rat in approximately 100 per cent of normally non-susceptible animals, males or females, castrates or non-castrates, that live through the required time limits of six months or more and which are given the proper dosage of estrogens (Figs. 1-*A*, 1-*B*, 1-*C*). The mammary cancers induced have metastasized to the mediastinal lymph nodes and lungs in several instances.

Roughly, twenty-five or more times the maximum physiologic dose is required to produce cancer in non-susceptible rats, if the hormone in oil is administered by daily injections. The time required for the appearance of the cancer is inversely proportional to the dose, if the estrogen in oil is injected daily. The minimum dose is about 30 gamma daily with a time of approximately 600 to 700 days with daily injections—with 200 gamma daily the time is from 150 to 200 days. Total doses are from 30 to 40 milligrams of estrone compared to from 1 to 3 milligrams in mice. Cancers appear more quickly by implanting pellets of the crystalline hormone. From three to ten milligrams will produce cancer in from 50 to 200 days and in one

TABLE I.—ESTROGEN-INDUCED MAMMARY CANCER

Author	Strain	Percentage Spontaneous Cancer	No.	Dose	Mammary Carcinoma
Lacassagne	R-3	72 at 12 mos.	68	300 I.U. wkly. estrone benzoate, estrone, equilene, equilenine	52 17–28 wks.
	XVII R-4	2	14	300 I.U. wkly. estrone benzoate	9 45–72 wks.
	XVII NC, XXX, XXXII (CBA)		111	300 I.U. wkly. estrone benzoate	0 120 wks.
Burrows	Stock		539	0.01 per cent benzine solution on skin—estrone 2 wks. plus progesterone	3 25 wks.
Bonser	L.B.	67 at 12 mos.	21	300–500 I.U. wkly. estrone benzoate, estrone	3 43–53 wks.
	CBA	0	40	300–500 I.U. wkly. estrone benzoate, estrone	0 80 wks.
Cramer and Horning	DZ	60–70	6	0.01 per cent chloroform, estrone twice weekly	6 16–19 wks.
	Mixed		6	0.01 per cent chloroform, estrone twice weekly	0 25 wks.
Gardner, Smith, Allen, and Strong	A, CH-3, CBA	80	112	150–500 I.U. wkly. estrone benzoate and other estrogens	39 23–50 wks.
Suntzeff, Burns	D, A, C_3H, HB	43–60	87	300–420 I.U. wkly. estrone benzoate	27 28–30 wks.
	OB, C-57	0–9	25	300–420 I.U. wkly. estrone benzoate	0 52–56 wks.
					139 mice

case the cancer appeared in 21 days (Fig. 2).

The present series of experiments resulting in estrogenic mammary cancer in rats indicates that cancer results from the similar physiologic action, produce similar forms of mammary cancer.

(4) An essential series of pathologic changes in the mammary gland precede the appearance of cancer.

Fig. 1-*A*. Estrogen-induced mammary cancer in the rat. Photograph of a rat with multiple mammary tumors on the abdominal wall (Rat No. 1276).

physiologic action of the endocrine substances used rather than from a direct cancerogenic action dependent on chemical irritation. Genetic factors are of minor importance. There are four important lines of evidence concerning the etiologic significance of the physiologic action of the hormone.

(1) The cancers produced do not occur at the site at which the hormone is implanted or injected, but in a remote organ over which the estrogen exerts a physiologic control.

(2) The time required for the appearance of the cancers is inversely proportional to the physiologic intensity of the stimulus. The time required is reduced (*a*) if a higher daily dose is injected; (*b*) if a more constant means of absorption is provided (implantation of pellets), and (*c*) if compounds of greater estrogenic potency are administered.

(3) Synthetic estrogens of radically different chemical structure, such as estradiol benzoate and diethyl-stilbesterol but of

I. CANCERS DO NOT OCCUR AT THE SITE OF HORMONE ADMINISTRATION BUT IN A REMOTE ORGAN OVER WHICH ESTROGEN EXERTS A PHYSIOLOGIC ACTION

Mammary cancer in rats in response to estrogen is the result of a specific physiologic action upon the mammary epithelium. Direct contact with cancerogenic hydrocarbons failed to produce mammary carcinoma in the rats.

Pellets of 1, 2, 5, 6 dibenzanthracene and of 3, 4 benzpyrene were implanted in the mammary gland of rats. Fourteen rats (two males and twelve females) received implants of dibenzanthracene and eight rats (four males and four females) received implants of benzpyrene. The pellets were made by compacting the crystalline material into holes drilled into a steel plate, and each pellet weighed between 2.6 and 3.0 milligrams. Palpable tumors occurred in all of the rats implanted with dibenzanthracene within from 323 to 418 days, and in seven of the rats implanted with benzpy-

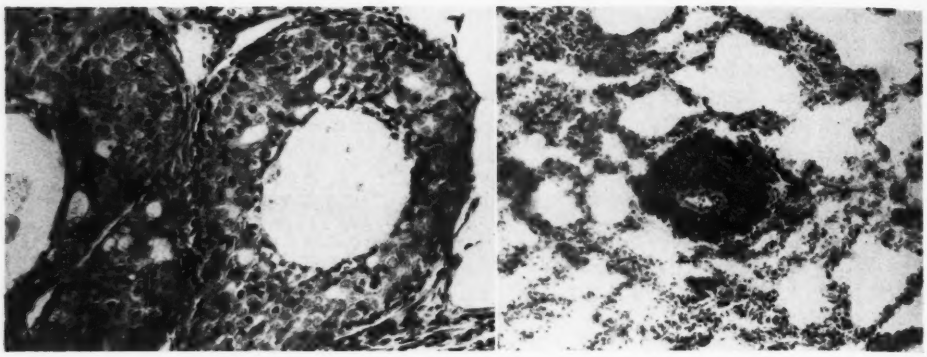


Fig. 1-*B*. Fig. 1-*C*.

Fig. 1-*B*. Photomicrograph of primary tumor (Rat No. 1276).
Fig. 1-*C*. Photomicrograph of pulmonary metastases (Rat No. 1276).

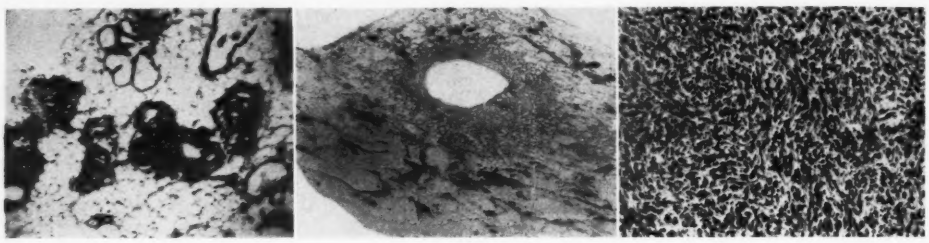


Fig. 2. Fig. 3-*A*. Fig. 3-*B*.

Fig. 2. Photomicrograph showing early duct cancer in the mammary gland of a castrated female rat 44 days old. The animal was castrated and the estrone pellets implanted on the twenty-third day of life. This tissue was removed on the forty-fourth day (Rat No. 1646).

Figs. 3-*A* and 3-*B*. Photomicrograph showing *A*, the pellet site in the mammary gland and, *B*, the fibrosarcoma of the stroma in a rat treated with 1, 2, 5, 6 dibenzanthracene pellets implanted in the mammary gland. The pellets were implanted on the twenty-seventh day of life and the specimens were taken on the four hundred and twenty-seventh day (Rat No. A-78).

rene within from 260 to 335 days. All of the tumors, however, were fibrosarcomas arising from the connective tissue and no mammary carcinomas were obtained. The mammary glands were sectioned through the pellet site and contact between mammary epithelium and the pellets was easily demonstrated. The effect on the adjacent epithelium was not remarkable. Atrophy and hypoplasia only occurred (Figs. 3-*A* and 3-*B*).

On the other hand, pellets of similar size of ketohydroxyestrin were implanted beneath the skin of the back in eleven rats of similar age and sex as those treated by cancerogenic hydrocarbons. No tumors occurred at the implantation site; nevertheless, eight of the animals developed palpable mammary carcinomas within ten months (Table III).

II. THE TIME REQUIRED FOR THE APPEARANCE OF THE CANCERS DEPENDS ON THE PHYSIOLOGIC INTENSITY OF THE HORMONE ACTION

(*a*) *The Higher the Daily Dose of Estrogen the Less the Time Required for Cancer.*— Mammary cancer results from ketohydroxyestrin (estrone) in oil injected subcutaneously in the back of the rat in daily doses above 25 gamma (250 international units). The cancer affects male and female castrates or non-castrates in similar fashion

when injections in oil are administered. The cancers appear n from 500 to 600 days when 50 gamma is injected daily, within from 350 to 400 days with 100 gamma, and within from 150 to 200 days with 200 gamma. Thus with injections of the hormone in oil daily the time is inversely proportional to the size of the dose, the total dose being relatively constant, from 30 to 40 milligrams (Fig. 4, Table II). In these experiments the injections were started in immature animals from 31 to 37 days old.

(*b*) *A More Constant Absorption of Estrogen Reduces the Amount of Hormone and the Time Required for Cancer.*—Mammary carcinoma in the rat occurs with smaller amounts of estrogen when the hormone is implanted in the form of pellets (Table III). As little as 7.5 milligrams of ketohydroxyestrin (estrone) in the form of three pellets will induce mammary carcinoma in 300 days.[4] By implanting several pellets simultaneously, cancer has occurred within 21 days. This is the most rapid production of cancer in the rat by experimental methods recorded to my knowledge. (The cancerogenic hydrocarbons acting directly on the stroma of the breast in the rat required from seven to ten months to produce fibrosarcoma.)

The gradual and constant absorption of hormone from the estrogen pellets accounts for the more effective action of the hormone when administered in this fashion. With this method of dosage, males are less susceptible to cancer than females. In these experiments it takes between four and seven months to absorb completely a pellet weighing three milligrams, about four millimeters in length, and about one millimeter in diameter. On the other hand, if the hormone is injected in oil it is more rapidly absorbed and more rapidly excreted. For this reason injections twice weekly (similar to those used in obtaining estrogen-induced mammary cancer in mice) are insufficient to produce mammary cancer in the rat. Daily doses are effective but less so than doses given twice daily or the implantation of pellets (Table IV).

(*c*) *Compounds of Greater Estrogenic Potency Require Less Time for the Production of Mammary Cancer.*—Since mammary cancer in the rat in response to estrogen varies with the physiologic intensity of the stimulus, the time of appearance of the cancer should vary according to the estrogenic potency of the compound. Repeated assays by the Allen and Doisy tests have shown that ketohydroxyestrin, estradiol, and stilbesterol differ in the number of rat units of estrogenic activity per gram. Table V gives the relative estrogenic values in rat units per gram for these various estrogens.

Using 100 gamma in oil daily injections in rats were carried out on the following compounds—estrone, estradiol-dipropionate, and stilbesterol. The time of appearance for cancers with these various estrogens is in accord with their relative estrogenic potency. The more potent estrogens produce mammary cancer in the shortest time. The average time for the appearance of cancer with 100 gamma of estradiol-dipropionate was 185 days, for stilbesterol 200 days, and for estrone 375 days.

III. ESTROGENS OF RADICALLY DIFFERENT CHEMICAL STRUCTURES BUT OF SIMILAR ESTRUS-PRODUCING ACTION ARE SIMILAR IN THEIR CANCER-PRODUCING ACTION

The fact that the chemical structure of the estrogens which are sterols, resembling that of the synthetic phenanthrene compounds which act as local cancerogenic agents in the skin and connective tissues, has received much emphasis in interpreting the production of mammary cancer in mice. By employing two classes of estrogens—a sterol (estrone) and a non-sterol (diethyl-

[4] Although the implantation of pellets produces mammary cancers more quickly and with less hormones than when injections in oil are administered, not all of the animals develop cancer within a given time limit. A constant absorption from pellets tends to produce fibro-adenomas instead of cancer, although secondary malignant change with cancer formation appears in the fibro-adenoma after a period of months. With this method of dosage in castrated males there is a high number of early deaths from urinary obstruction caused by squamous-cell metaplasia in the urethra.

stilbesterol)—it is possible to demonstrate that physiologic action rather than chemical structure is the controlling factor in estrogen-induced cancers of the mammary gland (Fig. 5).

TABLE II.—MAMMARY CANCERS IN THE RAT PRODUCED BY ESTRONE IN OIL INJECTED ONCE DAILY

Experiment No.	No. Rats (Castrated)	Estrone Dosage Daily	No. Cancers Produced	Age at Beginning of Treatment	Days Required to Produce Cancer
1	4	50 gamma	3 males	26 days	534–565
2	8	100 gamma	3 males 1 female	37 days	359–400
3	13	200 gamma	5 females	21 days	150–200

TABLE III.—MAMMARY CANCERS IN THE RAT PRODUCED BY IMPLANTATION OF ESTRONE PELLETS ONLY (2.5 mg. each)

No. Rats	Sex	Castrated	Total Dose Mg.	Pellets Implanted	No. Cancers Produced	Findings
				Day of Life		
7	F	no	7.5	2 28 153	6*	Palpable cancers 315 days
4	M	no	7.5	2 28 153	2	Palpable cancers 315 days

* One animal with four pellets implanted on twenty-third day had microscopic cancer on forty-fourth day of life; other microscopic cancers on two hundred fifty-fifth to three hundredth day.

Stilbesterol, a synthetic estrogen, but not a sterol, will induce mammary cancer, after an interval of time in keeping with its estrogenic activity. The cancers are similar to those induced by estrogens of the sterol class. These cancers induced with stilbesterol are further evidence in favor of the importance of the physiologic action in the etiology of mammary cancer.

IV. AN ESSENTIAL SERIES OF PATHOLOGIC CHANGES IN THE MAMMARY GLAND PRECEDE THE APPEARANCE OF CANCER

The early attempts to explain cancer on clinical and anatomical grounds such as chronic irritation, embryonic rests, and misplacement of germinal tissues do not apply to estrogenic cancer. The first attempts to explain the relation of estrogen to cancer were chemical and genetic. Lacassagne, in his early reports, postulated that the hormone stagnated in the mammary ducts, and acted as a chemical irritant on the mammary epithelium. He was compelled, however, to postulate also a genetic susceptibility, since cancer-resistant strains of mice did not develop mammary tumors in response to estrogen. Following this, Cramer—and later Lacassagne—adopted a physiologic explanation, attributing the effects to functional hypophysectomy. The hyperplasia of chromophobe cells in the anterior lobe of the pituitary gland was stressed as a probable cause of mammary cancer.

Pathologic effects on endocrine glands have been reported by most workers who have attempted to produce mammary cancer with high doses of estrogen. There is increase in the size of the adenohypophysis, with decreased numbers of basophil cells and increased numbers of chromophobe cells. Adenomas or adenomatous proliferations of chromophobe cells have

been reported. These hypophyseal changes were found at autopsy in the animals of the present series which had mammary cancer (Fig. 6). In addition, there were atrophic changes in the ovaries (in two animals there were granulosa-cell tumors of the ovaries), degeneration and calcification in the adrenal medulla, and varying degrees of hyperplasia and hypoplasia in the adrenal cortex.

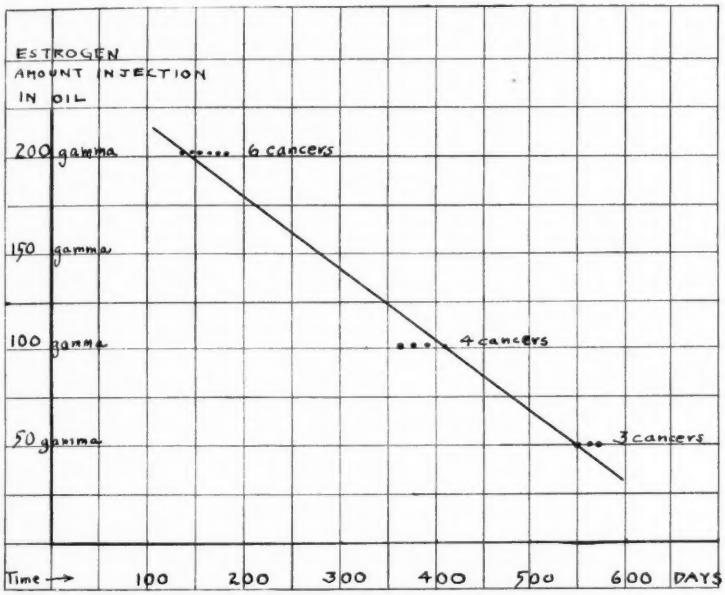


Fig. 4. Chart showing that the time of appearance of mammary cancer in the rat is inversely proportional to the amount of estrogen injected daily, subcutaneously in oil.

TABLE IV.—MAMMARY CANCER IN THE RAT PRODUCED BY ESTRONE INJECTIONS TWICE DAILY—PELLETS THEREAFTER

No. Rats	Sex	Estrone Daily Dose in Gammas	Injections Start	Injections Stop	Pellets Implanted	No. Cancers Produced	Findings
5	M*	50	1 d.	52 d.	153 d.	None	Epithelial proliferation; no palpable tumors (415 d.)
		25 b.i.d.	53 d.	153 d.	224 d.		
5	M*	50	3	21	104	1	Microscopic cancer in one animal (382 d.); no palpable cancers (455 d.)
		25 b.i.d.	22	104	190		
5	M†	50	2	15	55	0	All animals died of urinary obstruction (44–118th d.)
		25 b.i.d.	16	55			
4	F*	50	2	36	122	4	All animals had cancer (105 to 247 d.); two died with metastases (373 d.)
		25 b.i.d.	36	122	206		
8	F*	50	2	14	70	8	All animals had cancer; microscopic cancer (105–160 d.); palpable cancer (273 d.)
		25 b.i.d.	14	69	156		
					260		
11	F†	50	2	15	55	10	All but one animal had cancer; microscopic cancer (243 d.); palpable cancer (330–405 d.)
		25 b.i.d.	16	56	139		
					241		

* Non-castrated
† Castrated on twenty-second day of life
d—Day
F—Female
M—Male
Note: Nine additional rats—two females and seven males—died too early to be tabulated.

TABLE V.—PROPERTIES OF ESTROGENS AND THEIR DERIVATIVES

(Whitman, B., Wintersteiner, O., and Schwenk, E.: Beta-Estradiol. Jour. Biol. Chem., **118**, 789–795, May, 1937.)

	M. p. ° C	Physiological Activity
		Rat units per Gm.
Alpha-Estradiol	178	12,000,000
Beta-Estradiol	223	300,000
Alpha-Benzoate	195	6,000,000
Beta-Benzoate	157	150,000
Alpha-Diacetate	127	10,000,000†
Beta-Diacetate	141.5	
Dipropionate	104	5,000,000†
Estrone (ketohydroxyestrin)	258–260	1,000,000
Stilbesterol		3,000,000*

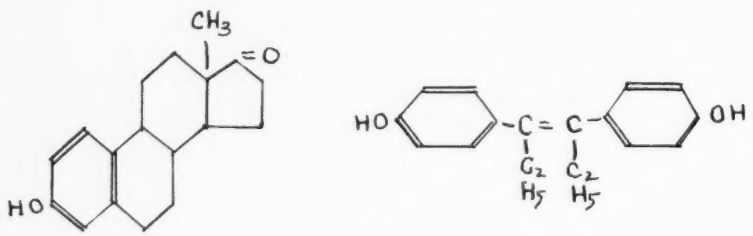
* Dodds, E. C., Golberg, L., Lawson, W., and Robinson, R.: Estrogenic Activity of Alkylated Stilbestrols. Nature, **142**, 34, July 2, 1938.

† Miescher, K., Scholz, C., and Tschopp, E.: The Activation of Female Sex Hormones: II.—Alphaestradiol and its Di-esters. Biochemical Jour., **32**, 725–732, April, 1938.

It seems unlikely, however, that the hypophyseal changes are of more than secondary importance, although the mammary changes resulting from estrogen stimulation are prevented by hypophysectomy as demonstrated on a group of rats in this series. The same effect, however, was also demonstrated by partial starvation. It seems probable that the hypophysis is necessary for metabolic activity which enables the mammary epithelium to respond by ripening and differentiation to the estrogenic stimulus. Mammary cancers of large size resulting from estrogen showed progressive growth in spite of hypophysectomy performed after the cancers were well established.

The pathologic changes which precede cancer formation in the mammary gland depend on the method of dosage. With large cancer-inducing doses injected in oil the duct tree is stunted in size and irregular lobular buds appear at the ends of the ducts. (Enlargement caused by extension of the duct tree, such as occurs with small physiologic doses of estrone, does not occur.) With further injections, cysts form in the lobular buds, the cysts become distended with inspissated material, the epithelial lining atrophies, and in one or more areas epithelial proliferation of malignant character appears from remnants of the atrophic epithelium.

With cancer-inducing doses resulting from the implantation of estrogen pellets, over-dosage also results in stunting. This



ESTRONE STILBOESTROL

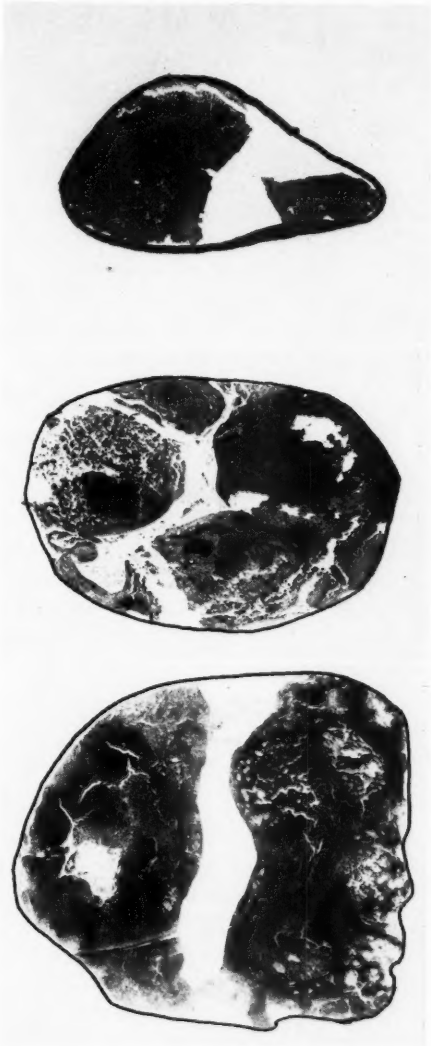
Fig. 5. Comparison of the structural formula of estrone, a sterol with the non-sterol estrogen—diethylstiboesterol.

PATHOLOGIC MAMMARY CHANGES WITH ESTROGEN OVERDOSAGE

Estrogen Injections in Oil	Estrogen Implanted as Pellets
1. Stunting of Duct Growth	
2. Atypical Lobular Buds	2. Irregular lobule formation
3. Cyst Formation in Lobular Buds	3. Fibro-adenomatous Growth or benign Fibro-adenoma
4. Accumulation of Inspissated Secretion in Cysts	4. Secretory and Cystic Changes in Fibro-adenomatous Areas
5. Atrophy and Degeneration in Lining Epithelium	
6. Cancer Formation in Regenerating Epithelial Elements	

initial effect is followed by atrophy of the lobular buds in some areas but elsewhere there is a branching of ducts and rapid proliferation of periductal fibrous tissue. True fibro-adenomas may form. In these fibro-adenomas and fibro-adenomatous areas there is then cystic dilatation and secretion in the ducts, resembling a benign fibro-adenoma during lactation. In the epithelial channels dilated with secretion, epithelial atrophy and malignant changes then occur, as in the final stages of the glands of animals subjected to daily injections of the hormone. The appearance of benign cysts occurs early with interrupted estrogen stimuli and fibro-adenomas result from continuous estrogenic stimulations. Benign papillomas are occasionally observed.

The variety of mammary cancers observed with the injection of estrogen are of interest. When the hormone is given by daily injections the cancers occur usually in the ends of the cystic terminal tubules and resemble the so-called comedo carcinoma seen in the human breast. Duct cancer may also form in these animals in the larger ducts beneath the nipple and resemble the more malignant duct cancer seen in the same region in the human breast. Both forms of cancer ultimately metastasize to the mediastinal lymph nodes and lungs, if the animals live for a sufficient period of time. However, metastases in seen only when the mammary tumors exceed one or more centimeters in diameter and they are fairly slow growing in character. Although microscopic tumors occur as early as the one hundred and fiftieth day, metastases have not been observed until about the end of one year after the onset of the experiment. When the hormone is given in the form of pellets, the cancer may occur in fibro-adenomatous areas. These are typical scirrhous carcinomas. The adenomatous areas contain large numbers of dilated acini and the cancer often arises directly from the acinar epithelium. In the present experiments the cancers usually arose from multiple foci and in nearly all animals more than one breast was involved. In the animals dying with metastases the entire abdominal wall may be covered by the mammary tumors.



Figs. 6-*A*, 6-*B*, and 6-*C*. Photomicrographs showing cross-sections of the hypophysis in *A*, normal control of rat, and *B* and *C*, rats with mammary cancers induced with estrogen.

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DISCUSSION

DR. CHARLES F. GESCHICKTER (*closing*): There is much evidence to indicate that the ovarian hormones play a rôle in chronic cystic mastitis. I have previously published studies showing that chronic cystic mastitis will occur in the rat's breast in response to increased or irregular doses of estrogen. Fibro-adenoma occurs in the mammary gland of the rat if a continued dosage instead of the interrupted injections are used. This is most important. To produce a fibro-adenoma instead of cystic mastitis in the rat, a pellet of crystalline estrone is implanted instead of injecting estrone in oil. Thus the pathologic results vary with the method of dosage. In the human being, the method of dosage that the ovary supplies is more or less continuous during adolescence (like a pellet) and discontinues during menstrual cycles (like injections once daily), when the patient approaches menopause without childbearing. Both experimental methods of estrogen dosage are represented naturally in the human breast.

Now as regards endocrine studies, on patients with chronic cystic mastitis: we have found that it is essential to study the corpus luteum function as well as estrogen excretion. The corpus luteum function can be studied by measuring the excretion of the metabolic product of progesterone-pregnandiol. But neither estrogen nor pregnandiol is satisfactorily studied from isolated urine samples. Total collection of urine in forty-eight-hour lots, from the eighth day following menstruation right up to the next menstrual cycle, are essential in the study of ovarian function. The only mistake in this procedure is not to take it from one menstruation up to the next menstruation. It is desirable to measure total output for the entire cycle.

In cases of chronic cystic mastitis we find varying degrees of deficiency in the corpus luteum hormone output as measured by pregnandiol. To date, we have only about ten to twelve normal patients studied, an insufficient number of controls as against fifteen cases of chronic cystic mastitis. Additional controls from the literature (Browne and Venning, Hamblen, etc.) cannot be used because the methods of assay differ and it is difficult to judge just what cases are really normal.

Needless to say, I do not think we are in a position yet to determine what the actual endocrine activity of the ovary is by any known method, whether from the study of the blood or urine.

We find it difficult to correlate our studies on rats with those on patients and we are trying to get a chemical method rather than a biological method for estrogen.

I have to say only that it takes several years to follow these mastitis patients properly. It takes a great deal of study, not only in regard to total urine output, but we find we have to repeat these studies over several months during the year, because, in mastodynia, the patient will run along with three or four abnormal cycles and subsequently will run a normal cycle. There is also a mechanical difficulty. Total urine specimens require a great deal of perseverance on the part of the patient and doctor, and I think it is too early to quarrel about results.

Conclusions.—I am going to answer only the questions that were directly asked of me. I will answer, first, Would you castrate those women who have cancer of the breast by irradiating the ovaries? I have followed two groups of young women, those who were not treated by x-ray castration and those who were. The groups were woefully small, one seven, and one, six patients. But my answer is this: Any large hard scirrhous cancer in a young woman, in the neighborhood of five or more centimeters in size, warrants castration by irradiating the ovaries, in my opinion. The patients with large tumors, who have been castrated, have done much better than the ones who have not.

I have seen patients in the thirties come back with symptoms of metastases three or four months after radical operation only was performed. Those who had irradiation of the ovaries came back with symptoms also, but not so quickly and some of them have gone several years, even though they had carcinoma in both breasts. So, at this particular time—I may change my mind next year—I would say, yes.

Now as to the effects of estrogen on cancer. Once the cancer is there, it is very difficult to ascertain the effect. In rats, if you give the estrogen after the cancer appears, it continues to grow at a better rate than if you stop. I certainly do not think estrogen has a beneficial effect on mammary cancer.

Now in regard to the two sisters that Dr. Hunt mentioned, I don't think he has to have rat experiments to justify his results. The clinical results certainly justify the irradiation of the ovaries which he carried out in these cases.

I have only one more question to answer, that concerning the relation of chronic cystic mastitis to cancer. The problem here can be traced to Virchow. First, because he is dead and can't object, and secondly, because he didn't take specimens of the breast at autopsy. If he had, all subsequent pathologists would have followed his lead and plenty of evidence indicating the presence of microscopic foci of chronic cystic mastitis in the normal breasts of women between 28 and 40 would be on record.

RELATIVE DEGREES OF RADIOSENSITIVITY OF TISSUE

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THE problem of radiosensitivity, expressed in terms of the degree of susceptibility of cells, both normal and pathologic, or tumors derived therefrom and their environing tissue to radiant energy, had its inception in the discovery of the efficacy and initial application, even empirically, of roentgen rays and radium as therapeutic agents in malignant disease. In the generally accepted definition of the conception, cellular radiosensitiveness represents the natural reactivity of different types of cells to a given quantity of radiation of a certain quality (average wave length), when the cells are exposed in a specific manner (scheme of irradiation), as estimated clinically by an experienced radiologist (Desjardins). Radiosensitiveness has been defined, by other investigators of the subject, as the relationship between the lethal dose for any particular tissue or tumor, according to its normal situation, compared with the lethal dose for some other normal tissue, like the skin or the bed of a tumor.

The actual basis for the study of the problem was established by Bergonié and Tribondeau who, in 1906 as a result of exhaustive studies upon adult and embryonic cells, and upon cells in a state of rest or of active division, enunciated the principle, which has since become a law, to the effect that actively proliferating cells are peculiarly radiosensitive; also, that the more embryonal the type of cell, the greater its radiosensitivity, and the more differentiated and highly specialized the type of cell, the greater its resistance.

Initial investigations of the phenomenon of radiosensitivity, instituted even prior to the aforementioned date, involved the determination of the specific susceptibility of the lymphocyte. Thus, in researches conducted between 1903 and 1905, Heineke found that when the entire bodies of animals were exposed to large doses of radiant energy they invariably died, and at necropsy it was observed that while most of their organs presented no abnormalities, the spleen, mesenteric and other lymph nodes, and intestinal lymph follicles revealed marked destruction of lymphocytes, varying according to dose of rays and interval between irradiation and microscopic examination, the stroma becoming more prominent as the number of intact lymphocytes diminished. Destruction began about two hours after irradiation and was marked by disorganization and fragmentation of the nuclear chromatin of the cells, with scattering of fragments between remaining intact cells and in spaces of the reticular stroma, resulting in almost complete destruction of lymphocytes in about 24 hours, accompanied and followed by progressive atrophy of the affected structures. Meanwhile, some reticular cells assumed a phagocytic property, ingesting degenerated nuclear chromatin until the lymphocytes in the lymphoid follicles were mostly destroyed, only a small number apparently resisting the action of the rays. Shortly after the commencement of lymphocytic degeneration, cells three or four times the size of lymphocytes, consisting of a large, eosinophilic body of protoplasm and a large oval or round vesicle-shaped nucleus appeared in the germinal center, and, as destruction of lymphocytes progressed, formed large clumps concentric in arrangement and suggesting epithelial pearls. After several days, these structures diminished in size, the cells gradually assumed the approximate aspect of connective tissue cells, and finally disappeared. The degree of lymphocytic destruction appeared proportional to the length of exposure to the rays. Differences in degree of tissue changes were attributed to variation in focal skin distance and in density of intervening tissues. Other animals irradiated for variable peri-

ods and examined from ten days to three weeks after death revealed more or less extensive regeneration of lymphoid tissue. Warthin, in 1906, examined tissues as early as 15 minutes after irradiation, and even then noted disintegration of lymphocytes. In his animals also, cellular degeneration continued for several days in the manner already described.

These original observations of the post-irradiative behavior of lymphocytes laid the foundation for the studies of lymphoid activity by Murphy and Morton, who, in 1915, reported the results of their experiments involving the rôle assumed by the lymphocytes in natural and induced resistance to transplanted cancer. They discovered that the induction of the refractory state to the latter by subcutaneous injection of defibrinated blood is invariably accompanied by a distinct lymphoid crisis in the blood of the recipient. While no increase in lymphocytes was observed during the interval between the immunizing injection and the inoculation with cancer, it occurred to a marked degree within 24 hours of the introduction of the cancer graft. It was observed further that when the latter exhibits a definite take in control animals there is no such lymphoid response, while in instances of natural immunity the phenomenon is similar to that seen in artificially induced immunity, although the period of increase is frequently delayed for several days or a week. It was concluded that the lymphoid crisis was not merely a concomitant factor in the immune period, but is essential to the process, as demonstrated by the fact that the destruction of lymphocytes by roentgen rays is accompanied by loss of natural or induced resistance to the growth of inoculated cancer. On the other hand, in his study of the part played by the lymphocyte in immunity to cancer, Prime found that in animals naturally resistant or artificially immunized to certain strains of rat carcinoma (Flexner-Jobling) and sarcoma (Crocker R 10 and Jensen) a marked reduction in the circulating lymphocytes is not followed by an appreciable decrease in the immunity of these animals to the inoculation of tumors.

In 1917, Mottram and Russ described their observations and experiments on the susceptibility and immunity of rats to Jensen's rat sarcoma, in which the important rôle of the lymphocytes in the healing of newgrowths and the extreme vulnerability of these cells to roentgen rays and to beta and gamma rays were demonstrated. On the assumption that the results obtained by them in animals apply also to malignant growths in the human subject, these writers suggested that particular care should be taken in the employment of radiotherapy to protect the rest of the body, more especially those parts in which lymphocytes occur, namely, bone marrow, lymphatic glands, and spleen, from irradiation. Mottram and Russ were among the first investigators to invite attention to the fact that while small doses of radiation stimulate the production of certain cellular constituents of blood, the liability of the destruction of cells by prolonged exposure to roentgen or radium rays renders imperative the avoidance of irradiation of any but malignant tissues, and, if possible, the restriction of the supply of blood to all tissues, malignant or otherwise, through which the radiation penetrates.

These earlier researches on the response of lymphocytes to exposure to radiation caused these cells and the tumors derived therefrom to be ranked first in the scale of radiosensitivity of the several species of cells, and paved the way for the observation by Desjardins, many years later, to the effect that marked regression within three or four weeks following irradiation is a positive indication of a tumor arising from lymphoid tissue.

The year 1912 witnessed the original demonstration, upon the basis of evidence obtained chiefly from laboratory experimentation, of the selective action of roentgen rays upon embryonic cells and the resemblance of the latter to cells involved in malignant growths. From these initial observations, as Hernaman-Johnson points

out, was formulated the now in part almost abandoned theory of the combined depressant and stimulant action of roentgen rays; that is, depressant to cancer cells because of their pseudo-embryonic character, and stimulant to their healthy environment, comprising reaction, formation of fibrous tissue, and destruction of malignant elements by natural processes. Only the second half of the theory appears to have survived in the light of accumulated evidence in favor of indirect rather than of direct action. Two familiar examples are afforded, one by basal-cell epitheliomas of the skin, which in certain instances disappear without perceptible reaction under a dose of roentgen rays too small to be regarded as in the least degree destructive, and the other by tumors of the breast, which sometimes disappear following fractional dosage insufficient even to produce pigmentation of the skin. Then, too, experiments have shown that if a tumor has received *in vivo* a dose ordinarily sufficient to cause it to disappear, it will, when removed and transplanted within a few days, grow vigorously in another animal. In a histologic study of the behavior of cancer grafts inoculated into an area previously subjected to the action of roentgen rays, Nakahara found that cancer cells implanted in a cutaneous region previously exposed to an erythema dose of roentgen rays revealed a succession of degenerative changes in all respects comparable to the frequently described stages of degeneration of cancer cells following roentgen-ray treatment. These findings were in marked contrast to others involving the survival and growth of grafts implanted in unexposed regions in the same animal. In Nakahara's opinion, since the changes are identical whether the cancer cells have been exposed directly *in situ* or merely implanted in the previously exposed skin, it follows that it is impossible to establish, microscopically, a direct injury from irradiation as the principal factor in the therapeutic action of roentgen rays on cancer.

In the course of their studies on the effect of the cellular reaction induced by exposure of cancer grafts to roentgen rays, Murphy, Hussey, Nakahara, and Sturm treated a transplantable mouse cancer *in vitro* as nearly as possible in the same manner as that employed in the treatment of human cancer, except that the dosage was increased, the growths having been removed at intervals of from five to six weeks, exposed to roentgen rays, and replanted in a new series of animals. The initial result of their experiment was to reduce slightly and transitorily the vigorous growth of the tumor. However, subsequent treatments were without effect either on the number of takes or the rate of growth of the tumor. On the other hand, Wedd and Russ, who investigated the effect of roentgen and radium radiations upon the vitality of the cells of mouse carcinoma, observed that freshly excised mouse tumors, when irradiated sufficiently by roentgen rays and subsequently inoculated into other mice, did not proliferate. The inhibitory effect appeared more marked when irradiation was brought about by soft, that is, longer wave length or easily absorbed roentgen rays, than when a very penetrating type, *i.e.*, short wave length rays, was used. Excised tumors irradiated for about one hour by the beta rays from 5.6 milligrams of radium bromide did not proliferate on transplantation, while an exposure of 18 hours to the gamma rays from the same quantity of radium proved insufficient for an appreciable inhibitory action. Histologic examination of grafts irradiated at intervals after inoculation showed that the cells of the parenchyma of the tumor persisted for several days, but were eventually replaced by fibrous tissue.

Results of experiments by Chambers, Scott, and Russ on the action of roentgen rays upon the transplant of a spontaneous carcinoma of the rat indicated a lowering of the animal's resistance to the growth of malignant cells, if it were given a comparatively large generalized dose of roentgen rays, while the precise reverse occurred when the animal was subjected to a series of exposures of exceedingly small quantities of roentgen rays.

Nevertheless, the aggregate results of these and other similar researches appear to cast considerable doubt upon the assumption that roentgen rays in a dose suitable for administration to a living animal, namely, an amount which will not produce a skin reaction, exert a very marked destructive action on cancer cells.

Finally, as Hernaman-Johnson reminds us, there is not a single instance of truly direct action by any agent or substance in the realm of therapeutics.

Local and generalized action of radium and roentgen rays upon tumor growth in animals was studied by Russ, Chambers, and Scott. One set of their experiments related to the effect of radiation in various doses upon malignant cells prior to inoculation. Here it was found that the rate of growth of the tumor was approximately one and one-third times that of the normal when the tumor cells had previously received a small dose of beta rays. While the number of animals used originally was insufficient to establish the fact, when the same experiment was performed under slightly different conditions with the identical dose of rays on seventeen animals, a similar increase occurred in the rate of growth of the tumor, namely, about one and one-half times the normal. A second group of experiments had for its object the investigation of the effect of the rays in various doses upon normal animals, with particular reference to body growth and the result of subsequent inoculation of malignant cells. It was demonstrated that the body weight of the rat increased 15 per cent more rapidly under small dose roentgen-ray treatment than that of untreated animals of the same initial body weight, the number of animals employed being large enough to preclude an accidental effect. Increased resistance to tumor inoculations of an animal previously given small daily doses of roentgen rays proved fairly constant. In view of the number of animals involved, namely, seventy-seven, with the same number of controls, it appeared quite improbable that reduction in growth of the tumor could have been due to anything but the roentgen-ray treatment. The third set of experiments concerned the effect of rays in various doses upon tumor-bearing animals. The quantitative reduction in the rate of tumor growth in the latter appeared sufficiently large to preclude the element of chance. It was remarked that there was less restraint upon the growth of the tumor when the latter was permitted to share in the small dose radiation treatment. The bearing of the results of these investigations upon the radiologic treatment of malignant disease in the human subject appeared to these authors to be twofold: First, it must be recognized that uniform irradiation of a large tumor in man is hardly possible, either with roentgen rays or radium. Although slight variations from the lethal dose would appear unimportant, nevertheless if the quantity of radiation which reached outlying portions of the growth should be so diminished in intensity as to become a small dose, for example, a small percentage of the lethal dose, it might exert a stimulating instead of a destructive effect on malignant cells. Second, with respect to the body as a whole, there is ample evidence to show that large generalized doses of radiation lower the normal resistance to tumor growth. However, this result is completely reversed when the normal animal receives very small generalized doses of roentgen rays, repeated at frequent intervals.

In their investigation of the action of radium on transplanted tumors of animals, Wood and Prime considered three important factors, namely, (*a*) time of exposure, (*b*) amount of radium element, and (*c*) distance between radium tube and tumor tissue. They observed that the effect of radium was diminished proportionally by the removal through filtration of the larger part of the beta rays. The gamma rays were shown to accord with the same general law which governed the beta rays. It was noted also that sublethal exposures retarded the growth of the tumor cells, while still shorter treatments appeared to stimulate cellular activity. The experiments of these investigators demonstrated fur-

ther that when only pure gamma rays were used, the required exposure was eight times as long as when gamma and hard beta rays were employed. The effect of radium radiations on tumor cells *in vitro* was less marked than that exerted on isolated cellular elements, thus accounting for the fact that an exposure which destroys a small metastatic nodule in man proves quite ineffective on a well-vascularized primary carcinoma. Wood and Prime believed that the data derived from these experiments, relative to quantity of radium element and time of exposure necessary for a given distance, might be applied with tolerable accuracy to human malignant tumors.

The extraordinarily high biologic sensitiveness of human carcinomas, originating from embryonal anlagen, to radium as well as to roentgen rays was demonstrated by Walthard upon a huge post-operative recurrence of a primary squamous epithelial carcinoma of the left ovary, irradiated with radium (skin erythema dose at a distance of 5 cm., with delivery of even less to more deep-seated tumor tissue), and on a mammoth abdominal tumor of similar origin (probably from an anlage of the central nervous system) with roentgen rays (two-thirds or less of the skin erythema dose).

Another group of investigators turned their attention to the consideration of the purely physico-biologic factors which determine the susceptibility of cancer cells to irradiation. A most exhaustive series of experiments with the physical properties of roentgen rays was conducted by Moppett from 1929 to 1932. The chorioallantoic membrane of the embryo chick was selected for the initial investigation of the differential action of the rays on growth and vitality of tissue. Here the reaction of the membrane to x-radiation revealed an alternation in degree through a succession of different wave lengths. The nature of the response was shown to be a function of the wave length, so that some wave lengths caused destruction and others specific stimulation. An inadequate dose of destructive radiation caused stimulation. Different types of tissue, epithelia, for example, appeared to be stimulated selectively by certain wave lengths. The various components of mixed radiation neutralized one another in their biologic action, so that the threshold dose for mixed radiation proved much greater than that for suitable homogeneous radiation. Evidence afforded by this initial group of experiments indicated a probable association of various biologic and pathologic changes such as proliferation and death, with definite chemical atoms.

A second set of experiments by Moppett involved the biologic reaction to x-radiation in relation to a phenomenon known as antagonism, the term implying a neutralization between different frequencies in respect of their biologic action. In these experiments an attempt was made to define an effective frequency band. In every instance the addition of frequencies outside the band tended to diminish or prevent biologic change. The observed fact that mixed radiation produces a refractory state, without any visible biologic change, suggested that both the action and its neutralization are associated with preliminary changes in the atom which may be regarded as some form of ionization.

In the third group of experiments, Moppett investigated the biologic reaction to x-radiation in relation to the area of tissue irradiated. From these experiments he obtained ample evidence that the threshold dose for a biologic reaction varies as the area irradiated, both when the allantoic membrane is exposed to homogeneous radiation and the skin of the rat to mixed radiation. This result, together with the phenomenon of fusion, Moppett believes explicable in part by a summation of stimuli from distant parts, in such a manner that an inverse square law is manifested when the area irradiated becomes small. He points out that distant regions may be affected even though an area under consideration reveals no visible change. The mechanism of remote action thus not being concerned with the production of visible

changes, such as hypertrophy and atrophy, but with an intermediate stage which follows the absorption of quanta and presumably the production of ionized atoms, as demonstrated in earlier researches. It seems to Moppett reasonable to suppose that the threshold dose would become enormously large if an exceedingly small area involving very few atoms were affected, and thus the law may presumably be extended to three dimensions. He adds that while a purely biologic overflow must be recognized in the general rounding off of inflammatory processes, it appears best in the present instances to regard gross biologic changes, such as hypertrophy and atrophy, as distinct phenomena which complicate somewhat the interpretation of effects depending on the atom.

In a fourth experiment, the biologic reaction to x-radiation in relation to time was studied by Moppett. Here the time curve presented a minimum value at about one to one and one-half hours, both when the allantoic membrane was exposed to homogeneous radiation and the skin of the mouse to mixed radiation. A previous minimum indicated at two hours or more was believed to be characteristic of the wave length used. Moppett also thinks that the positive factor here involved may represent a physical phenomenon, implying that when the rate of absorption of energy is small, the ordinary laws of probability are inapplicable, and the atom can only absorb quanta when it is in a certain state which recurs cyclically, and that the above phenomenon may be related to the biologic stage, implying a cyclical receptive state in the living cell, though this appears to him less likely. The factor of repair is also explicable as a physical or biologic phenomenon, expressible under the experimental conditions of the investigation as the equivalent of a current of $-1/4$ milliampere. Here a purely biologic process of repair which may complicate the interpretation of changes in the atom may be assumed to exist. The possibility of cumulative action, for which Moppett found abundant evidence in roentgenologic literature, may, he thinks, be explained as a breakdown of the biologic aspect of repair. Accumulated evidence would appear to indicate that resistance of mouse skin, both to mixed and homogeneous radiation, is much greater than that of allantoic membrane, although very probably the ultimate phenomenon is similar.

A fifth set of experiments, conducted by Moppett, dealt with the reaction of living tissues to homogeneous x-radiation produced by crystal diffraction. In some of these experiments the histologic appearances furnished the first direct evidence that the dual phenomenon of antagonism and selective action in the allantoic membrane applies as well to mammalian tissues, amphibian tissues, and a culture grown *in vitro*. In the course of these experiments, frog skin appeared to exhibit an equally high resistance as mouse skin, shown in previous experiments to be fifteen times more resistant to mixed and homogeneous radiation than allantoic membrane. While it proved impossible to compare the resistance with that of the short-lived cells in the cultures which were used, the variation in latent periods prior to the occurrence of any visible change afforded the opportunity for an interesting comparison. Thus, in the highly organized tissues of the mouse, presumably with a high rate of repair, several days were required to demonstrate the obvious tissue changes known as the biologic stage of a roentgen-ray action. Allantoic membrane, a temporary embryonal structure, revealed definite tissue changes in one or two days, and heart cells growing artificially *in vitro* showed a change in a few hours.

Finally, a sixth group of experiments involved the application of the results derived from preceding investigations to tumor tissue. Here Moppett found that changes produced by means of the lathe spectrometer A and the multiple spectrometer B served to connect tumor tissue with antagonism and selective action as a dual phenomenon in the manner already described for normal tissue. From the more practical standpoint of treatment,

three well-marked stages were distinguished, namely, underdose and stimulation, retardation and cure, and overdose. Moppett explains that stimulation merely implies growth in relation to a control. In his opinion, it is quite conceivable that the phenomena in question are a secondary stimulation to an inadequate injury, for which there is microscopic evidence, as opposed to the primary stimulation inferred in the case of the allantoic membrane.

As part of their general researches upon the action of radium on cancer cells, Crabtree and Cramer studied the effect of anærobiosis, hydrocyanic acid, and cold on the respiratory mechanism of the cell. They found that although all three alike served to diminish the functional activity of the respiratory mechanism, their effect on the susceptibility to radium was in opposite directions, anærobiosis diminishing and hydrocyanic acid and cold increasing such susceptibility. In view of the clinical evidence afforded by the fact that in a tumor which has received an apparently equal dose of radiation some parts undergo regression, while the rate of growth of others may be temporarily retarded, thereby demonstrating that a neoplasm is not necessarily homogeneous in its susceptibility to radium, Crabtree and Cramer concluded that the problem of successful radiotherapy is not solely the physical problem of the production of a homogeneous field of radiation throughout the tumor, but that the biologic condition of cells in different parts of the tumor should be considered. For example, as these investigators point out, unequal vascularization, with consequent variation in the supply of oxygen to different parts, leads to corresponding variations in the degree of susceptibility of the several parts.

As with the lymphocytes, which, as we have seen, afforded a basis for initial investigations of comparative radiosensitivity, the reaction of other cells, both normal and pathologic, to radiation is determined largely by their general physiology, but particularly by their rate of multiplication, structural character (loose or compact), and more or less active metabolism (mitotic activity). In accordance with this criterion, it becomes possible to classify the various species of cells with respect to their sensitivity as follows: (1) lymphoid cells; (2) basal epithelial cells of the salivary glands; (3) spermatogonial cells; (4) epithelial cells of the follicles of the ovary; (5) epithelial cells of the skin, mucous membranes, and gastro-intestinal tract; (6) epithelial cells of the lungs and the liver; (7) epithelial cells of the kidneys; (8) endothelial cells of the blood vessels, pleura, and peritoneum; (9) connective-tissue cells; (10) muscle cells; (11) bone cells, and (12) nerve cells.

While it is of uniform application, the law of Bergonié and Tribondeau cited heretofore, relates especially to lymphocytes, and is valid for other types of cells only in such ratio as the particular characteristics already enumerated are developed. For instance, the general assumption to the effect that pathologic cells are more radiosensitive than normal cells depends upon the extent of the effect of irradiation on the rate of mitosis as affected by the pathologic process. Thus, as Desjardins so pertinently remarks, each variety of cell possesses a specific range of sensitiveness to irradiation, with due allowance for variations and with reaction time as a criterion, and this specific sensitiveness appears as the dominant fact of radiology. From these and other similar observations of the effect of radiation on cell growth, was evolved the proof of direct action on certain cells, embryonal cells revealing the most marked and more highly differentiated cells less marked effects.

The Arndt-Schulz law, according to which small doses of roentgen rays or radium stimulate and large doses depress cellular metabolism, has received various interpretations. Fraenkel is of the opinion that there is, as the law states, a direct stimulative effect on the cells. On the other hand, Holzknecht rejected the theory of stimulative action, asserting that roentgen rays in any dosage invariably exert a destructive effect, the extent of the latter

being in direct ratio to the amount of radiation. Therefore, Holzknecht's conception of increased cellular activity resulting from small doses was not that of a direct stimulative action, but that of a depressive factor which frees the cells from a restraining influence. Fraenkel, on the contrary, believes that small doses actually stimulate by direct biopositive action of the rays. Desjardins regards the law as invalid, since, according to his observations, the acceleration in metabolism is followed constantly by more or less marked cellular degeneration and inhibition of function. He noted that regression with primary degeneration of cells is succeeded by a secondary or indirect stimulation, as, for example, the increase in connective tissue cells in certain tissues and organs following repeated irradiation, connective tissue being deposited to replace other cells which the rays have caused to undergo degeneration. Desjardins conceives of primary or direct acceleration of cellular metabolism as a defense reaction; that is to say, an effort upon the part of the cell to counteract or compensate for the noxious influence of the rays. According to this interpretation, continued acceleration of metabolism is impossible with the use of roentgen rays or radium, which either always cause degenerative changes or are without effect.

As a result of repeated experiments with the application of roentgen rays and radium and subsequent observation of the clinical behavior of tumors exposed to the effects of these physical agents, it was found that the susceptibility of tumors to irradiation agreed closely with the radiosensitiveness of normal cells of the same kind as those from which the tumors originated or of which they were largely composed. Accordingly, by a process of analogy it proved possible to classify the majority of the more familiar tumors in the order of their sensitivity as follows: (1) lymphoma; (2) embryonal tumors; (3) cellular anaplastic tumors; (4) basal-cell carcinomas; (5) adenocarcinoma and adenoma; (6) desmoplastic tumors (like squamous carcinomas, fibrocarcinomas) and (7) fibroblastic sarcoma, osteosarcoma, and neurosarcoma (Ewing).

Along with the establishment of the approximately relative degree of radiosensitivity of these neoplasms came the realization of the necessity for the consideration of the several factors, namely, physical, histologic, physiologic, pathologic, and clinical, which govern the response of tumors to irradiation and individually or collectively determine the final result of the therapeutic application of roentgen rays and radium.

A radiosensitive tumor has been defined as one that can be completely destroyed by a correct irradiation without permanent damage to the surrounding normal structures, and a radioresistant tumor as one that cannot be completely sterilized without serious and permanent damage to surrounding normal tissue.

Two distinct methods for the complete sterilization of a tumor by irradiation are generally recognized, namely, selective irradiation and caustic irradiation. The first of these, which is characterized by an autolytic reaction upon the part of the tissue which composes the tumor, occurs in embryonal or other multicellular, rapidly growing vascular tumors nourished by young, newly formed blood vessels, is the method of choice, since it sterilizes the cancer cells without serious damage to the normal surrounding structures, even with doses of rays which would produce necrosis in radioresistant tumors. Regaud advocates the employment of selective radiation instead of diffuse caustic radiation in all cases in which the surrounding normal cells are less radiosensitive than the cancer cells, this being in his opinion an indispensable requisite for the success of the procedure. The other method of non-selective caustic radiation involves the application to highly differentiated radioresistant tumors of doses sufficient to cause their destruction, although with serious injury to the surrounding normal tissue, usually resulting, in cases of extensive lesion, in so-called radionecrosis marked by ulceration, secondary infection, and local recurrence.

In these instances, no dose suffices to cause the death of the tumor without necrosis, and unless irradiation be extended beyond the zone of apparent involvement, viable cancer cells may be found in the ulcerated margin of the affected area. Thus the method is especially applicable to the treatment of comparatively small and more radioresistant tumors. A third method, characterized by a type of reaction which he entitles growth-restraining, has been described by Sante. The principal advantages from the utilization of this method are the production of large amounts of fibrous tissue around the individual cells or the entire tumor, this dense fibrous-tissue capsule choking off the tumor and hence restraining its growth. This type of reaction occurs in radioresistant tumors which have developed deep-seated focal necroses from sublethal doses of radiation repeated over a long period of time, or from intense interstitial irradiation, and is particularly adaptable to radioresistant tumors so large or extensive as to render complete destruction by caustic irradiation impossible.

The intrinsic radiosensitivity of newgrowths may, as Levitt has shown, vary in different regions, this fact occasionally leading to the assumption that the sensitiveness of the newgrowths themselves has perhaps varied. Experimental evidence adduced by Levitt would appear to indicate that identical growths in identical situations treated by identical methods may often respond in an entirely different manner. Occasional recurrences following the disappearance of all traces of a growth are attributed to (1) survival of a few cells, which, though injured, are capable of recovery; (2) persistence of the original cause of the disease, with consequent formation of another growth, or (3) re-infection of the region through retrograde flow in the lymphatics from unsuspected lymphatic glands.

Sante recommends that every malignant growth, whatever its size and extent of involvement, be subjected to the so-called "test of irradiation," namely, the application to the tumor of a single intensive course within the tolerance dose, and the observation of the neoplasm for three or four weeks for signs of regression. If complete regression ensues, the tumor may be regarded as of highly sensitive type; that is, of embryonal or highly vascular, rapidly growing variety. If partial regression occurs, this indicates that the tumor cells are somewhat more sensitive to irradiation than normal body tissues. If there is no regression whatever, probably no amount of radiation less than that capable of producing necrosis of normal body tissues will suffice to destroy the tumor. In the event of complete regression, it is likely that a single application will be all that is required, since tumors which behave thus will withstand almost as much radiation as resistant tumors, without undergoing ulceration. In instances in which partial regression results, further applications are indicated, either by the saturation method or by interstitial radiation within the tissue-tolerance dose. In the absence of all regression, the most intensive irradiation, with unfiltered or very slightly filtered rays, applied well beyond the margins of the growth is imperative.

The assertion that size is a determining factor in the response of malignant tumors to radium and roentgen rays, respectively, and that tumors of extremely large size disappeared when treated with radium, while tumors no larger than a hickory nut only occasionally disappeared as a result of the application of roentgen rays, is disputed by Molesworth and his associates, who adduce two cases of sarcoma of the ilium treated by deep roentgen therapy, the bone involvement in both instances presenting a maximum of at least 20 cm. in length and 15 cm. in breadth, the mass disappearing for the most part within two years and eight months, respectively. They also report a case of tumor of the hypophyseal region, slightly larger than a hazel nut, cured by deep radiotherapy, the condition of the patient appearing normal two and one-half years afterward; a case of recurrent sarcoma of the neck of approxi-

mately the size of a walnut, apparently cured in six months; also 39 additional cases involving tumors ranging in size from one-half to six centimeters in diameter and from five to ten centimeters in length.

One most important phase of the problem of radiosensitivity involves the study of gross and microscopic specimens of tumors removed following their exposure to various forms of radiation, with the object of correlating morphologic structure with radiosensitiveness and of estimating the changes produced in tissues by different doses of roentgen rays and radium. However, it should be pointed out here that while microscopic and histologic examination is occasionally of considerable aid in the selection of methods of irradiation and the prediction of the type of reaction in an individual instance, the determination of the degree of radiosensitivity from morphologic characteristics alone is sometimes impracticable. For example, a biopsy which necessitates the invasion of the surrounding zone of normal tissue entails a risk of the spread of the disease, and, under these circumstances, should not be performed. Then, too, it must be remembered that, as previously stated, the microscopic structure of a tumor is but one of the factors indicative of the property and degree of its radiosensitiveness. Indeed, the rate of regression of tumors has often proved a far more dependable means of identifying and classifying the more radiosensitive varieties of neoplasms than microscopic examination. In Cutler's judgment, an obligation rests upon all pathologists, who venture to express an opinion on radiosensitivity, to familiarize themselves with the essential principles of, as well as with current progress in the subject. In the absence of such knowledge upon the part of the pathologist, Cutler believes that a reliable estimate of radiosensitivity in relation to treatment can be made only by consultation between the pathologist and the radiotherapeutist.

As previously remarked, the cause of the high radiosensitivity of certain tumors has been traced to the peculiar physiology of their cells of origin. As shown by Desjardins, radiosensitiveness depends not only on the natural susceptibility to radiation of cells chiefly composing the neoplasm, but also on their rate of metabolism or mitotic activity, their metabolic stage at the time of irradiation, and possibly their blood supply. Radiosensitivity increases with increasing embryonal character of tumor cells, and decreases when embryonal tumors acquire adult characteristics. It increases also with an increasing degree of anaplasia, except in the case of those anaplastic tumors which are not radiosensitive. Stewart suspects that some physiologic mechanism as yet undiscovered is involved in the prompt response to radiation of certain tumors and to the comparative absence of such a reaction in others. High general vitality of tumor and host constitute essential factors in radiosensitivity (Ewing). So-called "radio-immunity," thought by some to be induced by repeated courses of irradiation, Hernaman-Johnson attributes rather to "staleness" or exhaustion of powers of response of surrounding tissue. Also, as Ewing explains, the tumor cells themselves may in consequence of several treatments, usually of considerable severity, acquire a high degree of resistance to radiation, and become, so to speak, "radium-fast," all the while retaining their original vitality, as evidenced by occasional revival of activity and rapid spread of the tumor, indicating that the capacities for growth of the latter have been increased by stimulation. Certain other physiologic phenomena, prominent among them the function of secretion, are assumed to affect radiosensitivity to an extent not as yet precisely determined.

There is still considerable doubt as to whether or not malignant tissue is really more sensitive to the effects of irradiation than the normal tissue from which it arose. Among the various theories which have been advanced in an endeavor to account for the results obtained with roentgen rays, the two most tenable appear to be (*a*) that the cell in process of division exhibits an increased susceptibility to the

rays, and (*b*) that the effect obtained from roentgen therapy arises from induced obliteration of the blood vessels, with consequent diminished nutrition of the new-growth. As already asserted, a high rate of metabolism with attendant rapid growth of tumor cells, vulnerability of mitotic nuclei, and abundance of autolytic cell ferments are likewise regarded as factors of probable importance in the sensitivity of rapidly growing tumors. Differences of opinion exist with respect to the influence of high vascularity on the behavior of tumors under irradiation, despite the evidence that highly vascular tumors disappear rapidly as a result of progressive obliterative endarteritis with eventual cutting off of the supply of blood and termination in massive necrosis. The location or bed of the tumor also affects markedly the results of irradiation, a normal tumor bed yielding a generally favorable and an avascular bed an unfavorable response. It is well known that tumors situated in poorly vascularized tissues, as, for example, bone and cartilage, are especially radioresistant. However, of all the factors involved in radioresistance, perhaps the most important is the so-called desmoplastic property, defined by Ewing as the tendency to produce growth of connective tissue, which is possessed by certain tumors, notably epidermoid carcinomas and various sarcomas, also most glandular carcinomas, although Ewing adds that even the most cellular anaplastic types of squamous epidermoid carcinomas and sarcomas retain sufficient of this primitive function to render complete sterilization difficult. Finally, as Welsh points out, accidental anatomic and regional conditions may explain why a given type of carcinoma is radiosensitive when growing in one part of the body and radioresistant when growing in another part, though he believes that inherent cell capacity for resistance to irradiation should be regarded as a factor here. In his opinion, the physical properties of the cancer as a whole (chiefly its mass) and the possible resistance offered by the invaded non-cancerous tissues, through the development of tissue reactions, constitute further factors of fundamental importance for the problem of radiosensitivity.

In the words of Cutler, the only absolute test of the radiosensitivity of a tumor is its clinical behavior. He emphasizes the fact that a comprehensive knowledge of the latter is especially essential above all in the treatment of early cancer either by radium or roentgen rays. Here the results of microscopic studies have in frequent instances been contradicted by subsequent clinical observation of tumors in course of treatment by irradiation. Thus, tumors declared highly radiosensitive upon evidence afforded by their microscopic structure have ultimately been proved markedly radioresistant, and *vice versa*. It is thought that undiscovered biologic factors which reveal no microscopic indication of their existence are perhaps in part responsible for these anomalies.

1726 Eye St., N. W.

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MOTILITY OF THE GASTRO-INTESTINAL TRACT IN MAN AS OBSERVED IN PLANE-KYMOGRAMS[1]

By DR. GEORG AUGUST WELTZ, *Munich, Germany*

CERTAIN terms should be defined to avoid misunderstanding. *Tonus* is defined as the length of the muscle fibers at rest. The degree of tonus is variable, and contractions and peristaltic waves are superimposed on it.

Peristalsis is a special type of contractile wave which maintains the diameter as it progresses across an organ in a definite direction.

Spasms are localized contractions of the intestional wall which do not progress.

I. *The Stomach.*—The laws of peristalsis of the intestines of the routine laboratory animals can, according to the researches of Cannon, W. Straub, and P. Trendelenburg, and others, be summarized as follows:

"Peristalsis is originated by a stretching-stimulus of the intestinal contents. There exists a stimulus-threshold for it. This threshold is higher, the slower the increase of pressure occurs which leads to the expansion."

"Furthermore, the height of the pressure stimulus depends on the absolute tonus of the circular musculature. The threshold is lower with high tonus, and higher with low tonus."

The plane-kymograms demonstrate that these laws apply also for the human stomach. The effect of the stretching-stimulus can be demonstrated by shifting the stomach contents by standing or by reclining in a steep Trendelenburg position or by insufflation of stomach by carbon dioxide. A general increase of the intra-abdominal tension by pressure on the abdominal wall does not cause peristalsis unless an expansion-stimulus occurs by it. The usual palpation of the stomach during fluoroscopy initiates peristalsis if it produces a stretching of the muscle fibers.

The effect of the tonus on the threshold of peristalsis can be demonstrated on stomachs with great and sudden variations of tonus. With a low degree of tonus, peristalsis frequently becomes quiescent; with the increase of tonus, peristalsis starts suddenly. If the tonus decreases again, peristalsis ceases and the peristaltic wave just formed is interrupted. Thus tonus is the leading factor in the interrelation of tonus and peristalsis and the behavior of the peristalsis can be understood only by this control of tonus. This is of great importance in the practical evaluation of stomachs and, therefore, more attention should be paid to the behavior of the tonus.

The starting of peristalsis right after the filling is understood to be the result of the stretching-stimulus. The stretching-stimulus, however, must become less with the progressive emptying of the stomach. The peristaltic emptying of the last traces of stomach contents cannot be explained by the distention stimulus (because distention is no longer present).

The complete emptying of the stomach can be understood only with the assumption of a steady increase of tone during the progressive emptying of the stomach. Numerous kymograms suggested that the original tonus of the empty stomach is high and that this primary high tonus is decreased by the filling of the stomach. This regulation of tonus seems to be some crude control for the emptying of the stomach and the accurate regulation of the pyloric reflex is superimposed on it.

If the crude and the accurate control of the stomach is absent on account of stenosis of the pylorus (for instance, in carcinoma of the pylorus), irregular cuff-like contractions and spasms of the antrum may occur instead of peristalsis. They are similar to the first stage of vomiting. They lasted, in one case, from beginning to end, about 15 seconds.

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

II. *Small Intestine.*—Beside the peristaltic wave there is a second kind of propulsive movement in the small intestine. It is rather frequent and occurs especially if large quantities are suddenly put into the small intestine. It also occurs in any kind of pyloric insufficiency and in stomachs that have been operated upon. Their course is shown diagrammatically in Figure 2.

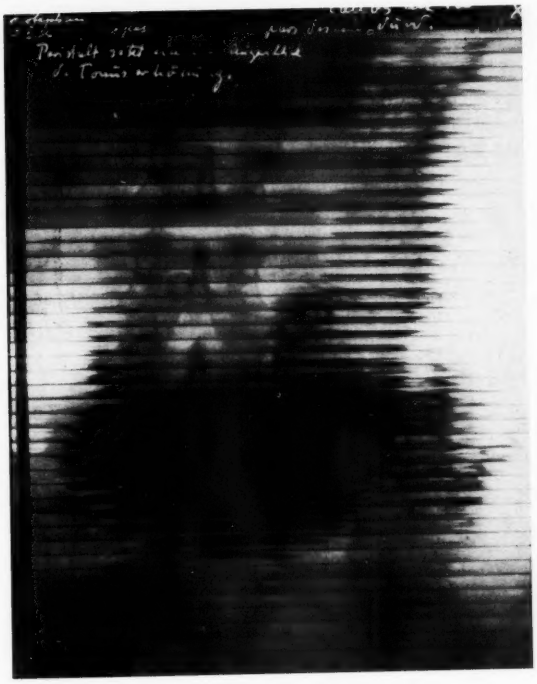

Fig. 1. Great and sudden variations of tonus of the stomach in case of chronic ulcer. No peristaltic movements if tonus is depressed. Strong peristalsis if tonus is augmented. Exposure about one minute.

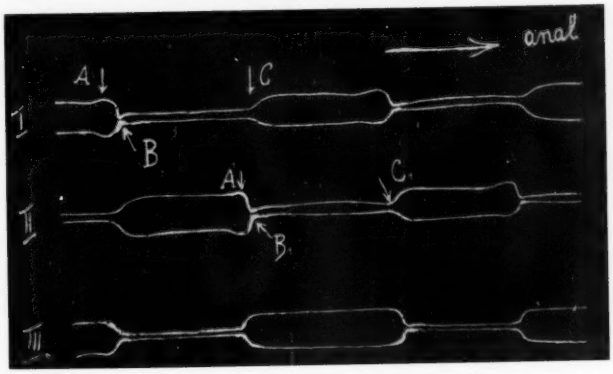

Fig. 2. Propulsive movements of the small intestine by means of segmental contractions.

The distance from B to C is, as a rule, from 2 to 3 inches. The ring at B and B_1 contracts just before the rest of the intes-

tine. This contraction does not progress down the intestine like a wave and is, therefore, quite different from the peristaltic wave. This movement differs from the "segmental," "swinging movement," or "mixing movements" by involving a larger area of contraction and by its propulsive movement which advances the intestinal contents.

We propose the term "propulsive movements by means of segmental contraction."

For this movement were measured:

Periods:	6	3	1.5	2	3
In seconds:	69	28	15	68	28

The length of the period is largely dependent on the speed of the influx.

Distances advanced were measured as:

Cm.:	45	45	60	35
In seconds:	38	39	14	15

The advancing distance increases also with the amount and speed of the influx.

III. *Large Intestine.*—The usual picture of colonic movement is a slight restlessness of the haustra, whose activity may frequently increase in a single segment without any obvious reason. A shift of the haustra in the direction of the rectum occurs but is rare.

If one takes continuous kymographic tracings of the colon over a period of 15 minutes, the haustra show, as a rule, only small accordion-like movements. Their number, however, stays about the same and their position is hardly altered. Changes in tonus of larger segments of the colon occurred, and, as a rule, can be recognized by slight contractions. These could be identical with the so-called "minute variations."

Transportation of intestinal contents toward the anus occurs so rarely that during an observation period totalling 12 hours an advancement of the contrast meal would be noticed only three times. Once it occurred by concentric contraction of the ascending colon.

Stomach-like peristalsis does not normally occur in the colon, but has been observed by the kymograph in an incomplete obstruction in the middle of the transverse colon. This obstruction caused a congestion and expansion proximal to it. A very pronounced peristaltic wave advanced in about eight minutes from the right flexure to the middle of the transverse colon. This slow speed of advancement cannot be registered during fluoroscopy and can be visualized in plane-kymograms only with a corresponding speeding-up of the exposures in reproduction (about 200 times). A complete obstruction in the colon can cause repeated cuff-like contractions as in pyloric stenosis. This movement lasted longer than seven minutes.

Thus several definite analogies exist between the movements of the stomach and the colon but the movements of the latter are decidedly slower, and, therefore, they frequently cannot be observed during fluoroscopy.

Furthermore, tonus changes exist which are present simultaneously in the stomach and in the colon. The kymograph confirms the observations made by Weitz and Vollers by means of the balloon-sound. These simultaneous tonus changes can explain the frequent observation that filling of the stomach leads to a defecation stimulus.

ROENTGEN DIAGNOSIS OF HEMANGIOMA OF THE LONG BONES[1]

By PROFESSOR M. J. NEMENOV, Director of the State Roentgenological, Radiological, and Cancer Institute, *Leningrad, U.S.S.R.*

THE present paper gives a description of a case of hemangioma affecting the bones of the forearm which was diagnosed from a roentgenologic examination of the patient. In spite of the fact that there have been a number of roentgenograms published in the medical press of the world showing hemangiomas of long bones, none of the cases reported has been diagnosed on the strength of its roentgenograms, the diagnosis having been made either after an operation or a biopsy.

Hemangioma is of very frequent occurrence. In the vast majority of the cases it is found to affect the skin and the subcutaneous tissue; less frequently it involves other soft tissues and viscera, such as the muscles, liver, spleen, and brain, but much more rarely does angioma affect the bones.

Hemangioma should undoubtedly be regarded as a tumor or neoformation, for in this case we have not merely to deal with the enlargement of capillaries and minor blood vessels, but also with their neoformation and tumoral growth, as has been proved by the investigations conducted by Virchow and later by Ribbert. Beside, hemangioma is characterized by its infiltrating growth resulting in the atrophy and destruction of the surrounding tissues. In this respect, hemangioma resembles a malignant tumor. However, actually hemangioma belongs to the group of innocent tumors, for, as a rule, it produces no metastasis. It is true that we may observe multiple hemangiomas, but they cannot be regarded as being of a metastatic nature and should be considered as having originated from numerous foci disseminated throughout the organism. Two types of the tumor are distinguished—hemangioma simplex and angioma cavernosum—but there seems to be no essential difference between the two, except that in the latter variety the formation resembles a cavernous body.

A section of the tumor reveals a spongelike structure, consisting of porous connective tissue containing elastic fibers. The nuclei are lined with a layer of endothelium and filled with blood.

Of all the bones of the skeleton, the vertebræ are most frequently affected with hemangioma; then come the bones of the skull, while the long bones are least frequently affected. According to Töpfer's data obtained by making a longitudinal section of the vertebral column in 2,154 cadavers, hemangioma of the spine was observed in 257 cases (11 per cent). Out of this number, the spinous processes were affected in four cases and the bodies of the vertebræ in three cases. It was noted that hemangioma affected most frequently the middle and the lower dorsal vertebræ.

The size of the tumors varied between that of a pea and a formation completely filling the body of the vertebra. Not infrequently the bodies of several vertebræ were involved. The intervertebral cartilages remained intact.

To judge by Töpfer's data, hemangioma of the vertebræ may develop in the vast majority of cases without causing any symptoms whatever, for his observations were carried out on the corpses of patients who had died of various diseases.

Hemangioma of the vertebra is attended with clinical symptoms only when the affected vertebra increases in size in the direction of the vertebral canal, which results in reducing its size, thus compressing the spinal cord and the nerve roots.

[1] This is one of a series of papers contributed by friends and former pupils of I. Seth Hirsch, M.D.

In such a case, the patient complains of gradually increasing pains of a neuralgic nature. The process may result in paraparesis or paraplegia.

The bodies of vertebræ affected with hemangioma may be subjected to compressional fracture with all its consequences (*viz.*, the formation of a wedge-like vertebra, kyphosis, and paraplegia). However, such cases which have been described by Jungbiavus, Bucy and Kapp, Zdansky and others, are by no means of frequent occurrence.

In 1926, Perman first gave a description of the roentgen picture characteristic of hemangioma of the vertebræ. The bodies of the vertebræ affected with hemangioma appear to be thickened and their lateral surfaces are not infrequently concave. The affected vertebræ protrude more or less over the normal vertebræ. This is made particularly clear by roentgenograms showing the lateral view of the spine. In these roentgenograms, the affected vertebræ protrude both anteriorly and posteriorly in the direction of the vertebral canal. The normal sponge-like structure of the vertebral bodies is found to be changed and they appear to be covered with longitudinal lines. The vertically lying bone-plates are thickened and are separated from one another by more or less wide interstices (or nuclei), filled with the tumoral tissue, which admits the passage of the rays more readily.

The film observed in compression fracture in no way differs from that shown by compression fracture resulting from any other cause. The intervertebral spaces are not contracted, as the intervertebral cartilage remains intact.

Thus, the diagnosis of the not infrequently occurring hemangioma of the vertebræ produces no characteristic clinical symptoms and should be diagnosed roentgenologically.

As has been previously mentioned, hemangiomas of other bones, the long bones in particular, are of rare occurrence and, so far, no one has diagnosed the disease previous to operation or biopsy.

There are a number of cases cited in the literature in which hemangioma of either flat or tubular bones has been diagnosed following operation or biopsy and in which the diagnoses were made both previous to surgical interference and following it from the preparation obtained in the course of the operation. These roentgenograms are characteristic and, if taken into account, will make it possible to diagnose the disease in the future. The correct and timely diagnosis of hemangioma of the bones is of enormous practical value. Experience has shown that hemangioma of the bones is often taken for a malignant tumor and the patients have not infrequently been subjected to amputation of a limb or other injury owing to a faulty diagnosis.

Bucy and Kapp describe eight cases of hemangioma of the bones, of which number roentgenograms were made in seven. Two of the seven cases were affected with hemangioma of the vertebræ, the remaining five, with hemangioma of other bones, *viz.*, the cranium, the clavicle, the scapula, the femur, the ulna, etc. In none of the cases was the disease diagnosed before operation. However, the study of the roentgenograms presented by Bucy and Kapp clearly reveal a number of roentgenological signs characteristic of hemangioma affecting flat and tubular bones.

At the site of involvement with hemangioma, the bones are thickened. The structure of both the sponge-like substance and of the compact layer is greatly changed. The bone appears to have a nuclear structure, the latter sometimes spreading to the very periosteum. However, the periosteum is hardly ever impaired and the tumor does not penetrate into the adjoining tissues. Nor does the tumor grow into the epiphyseal cartilages or penetrate into the joints. In flat bones, as well as in other bones having a large diameter (as the head of the femur), it is possible to see that the osseous substance forms a center from which the osseous plates spread radially, resembling a colony of the ray-fungus. The nuclei formed by the osseous beams are usually small in

size, as in the case of hemangioma of the forearm which I have had occasion to observe. But sometimes they may be larger and resemble the picture usually presented by a giant-cell tumor or echinococcus of the bone. However, in the case of hemangioma, the larger nuclei are in their turn penetrated with a fine-looped network of osseous substance. Beside, in the case of a giant-cell tumor the bone appears to be inflated and always has a cortical layer, however fine. In hemangioma, as we have previously mentioned, the nuclei reach as far as the periosteum.

Fig. 1.

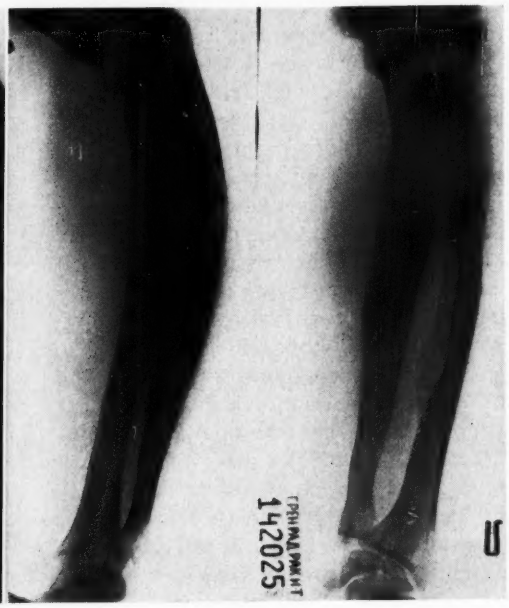

Fig. 2.

Fig. 1. Photograph of the upper extremities of the patient.
Fig. 2. Roentgenogram of the forearm of the patient. *A*, side position (lateral); *B*, posterior position.

The case I intend describing is of interest because I succeeded in diagnosing the disease from roentgenograms and previous to biopsy.

Patient P. F., aged 37, a newspaper worker, entered the clinic of the State Roentgenological, Radiological, and Cancer Institute, on May 21, 1938. A slight deformation of the left forearm had been noticeable since his early childhood. At the age of eight years, the patient fell from a cart. A fracture of the upper third of the left forearm was diagnosed. The boy had his arm in a splint for three months. A year later he had another fall and again broke his left forearm; he again had his arm in a sling for three months. In two years' time, when the boy was 11 years of age, he fell once more and fractured his forearm for the third time. When the fracture healed the forearm was much deformed and showed a marked curvature.

Until 1926, when the patient was engaged in manual labor, he often suffered from dull pains in the left upper extremity but did not consult a physician until 1931. In 1931, the patient fell and hurt his left forearm. For four months he had his arm in a plaster of Paris bandage. A roentgenogram of the extremity was made but the disease was not diagnosed. Since the time of the last injury, the pains had become incessant and were particularly

severe at night. He was no longer able to work. In 1938, in the Krasnoyarsk Clinic, amputation of the left arm was suggested to the patient, since the affection had been diagnosed as sarcoma.

Beside the above-described injuries, the patient had had measles as a child and, later, croupous pneumonia. There was no history of venereal diseases. The man was married and had two healthy children.

The patient is of average height, normal build, and shows no signs of emaciation. His left forearm is markedly deformed, being considerably thickened, particularly in its upper external portion, and shows a bow-like outward curvature. The circumference of the middle of the left forearm is 27 cm., while the right forearm measures 24.7 cm. around a corresponding line. The muscles of the left arm are atrophied and the circumference of the left arm measures 22.5 cm., while that of the right is 26 cm., at a corresponding level. Flexion and extension in the left elbow joint present no difficulty. Pronation and supination are markedly limited. The movements of the left wrist are quite free. The skin is shiny and shows signs of tension, as well as of cyanosis; arm is somewhat edematous. The viscera showed no deviations from the normal, nor were there any symptoms of disturbed nervous system. The blood test yielded the following data: hemoglobin, 95 per cent; erythrocytes, 5,080,000; leukocytes, 8,700; of that number, 58 per cent were neutrophils, 34 per cent lymphocytes, 3 per cent eosinophils, 1 per cent basophils, 4 per cent monocytes. The urine was normal; temperature, within the normal. Wassermann test, negative; Catzoni's test, negative.

The roentgenogram showed marked changes of both bones of the forearm, particularly of the ulna. The changes in the ulna are visible, beginning at a level of about five centimeters below the elbow joint. In the radius, they begin somewhat more distally. The changed structure of the bones spreads to a level of about sixteen centimeters above the radiocarpal joint. The ulna shows a marked change of structure throughout its thickness. Its structure is nuclear and the larger elongated nuclei in their turn are divided by a fine network into smaller ones. Up and down in the direction of the normal part of the bone, the nuclear structure becomes less evident; the periosteum seems to be intact with the exception of one section along the borderline between the upper and middle portions of the ulna. The changes in the radius affect the region of the interosseous spina. However, the nature of the changes is the same as those observed in the ulna, the same nuclear structure, though not as densely penetrating the entire thickness of the bone.

Thus, in our case, we had to deal with an individual who had suffered from a deformation of the bones of the left forearm since his early childhood and a liability to fracture in this region. The affection was constantly progressing for a considerable number of years. The roentgenogram revealed a reconstruction of the bones of the left forearm, its finely nuclear structure, and a practically unimpaired periosteum, in spite of the complete reconstruction of the compact layer of the left ulna. The morbid process had not affected the joint.

The above-described signs, as well as the patient's anamnesis, entirely excluded the possibility of a malignant neoformation. The finely nuclear structure, the destructive changes in the compact layer, and the considerable spreading of the affection were all contrary to a diagnosis of giant-cell tumor. The clinical picture revealed was still less likely to have been caused by echinococcus disease of the bones.

On the grounds of the analysis presented, I was led to conclude that we had to deal with hemangioma of the bones of the left forearm. On May 23, 1938, a biopsy was performed under local anesthesia. No pressure bandage was applied. The incision of the soft tissues was attended with severe hemorrhage which was stopped by

means of clamps. The periosteum was separated in the central portion of the ulna. The cortical layer was found to be absent. The bone yielded readily to the chisel, a piece measuring 3.5 × 1.5 cm. being removed. The gap in the bone showed a honeycomb structure. The removal of the sample caused bleeding from the bone. Ligatures were applied and the wound sutured. The latter healed by first intention.

The histologic examination of the removed portion of the bone yielded the following data: The structure of the bone was disturbed; the compact layer was absent, and there was a sponge-like structure throughout its thickness. The osseous beams were normal in their structure and contained distinct groups of osseous plates. The cells (*viz.*, the osseous bodies) were apparently normal. No bone marrow was present between the osseous beams. Some of the cavities were filled with blood; others were empty, and all were lined with endothelium. Diagnosis: angioma cavernosum (Garshin).

Thus, my roentgenological diagnosis was confirmed by an histologic examination.

There are two ways of treating hemangiomas—either by surgical interference or by x-ray or radium radiation. The surgical method consists of a subperiosteal resection of the bones affected. However, this is not always practicable when the affection has spread over a large area, as was the case in the patient we observed. Sometimes it proves possible to confine the operation to the kind of enucleation which is generally performed for giant-cell tumors. At any rate, the amputation of a limb should never be resorted to in treating hemangioma. This makes it most important to have the disease correctly diagnosed. The other method of treating hemangioma of the bones, that of x-ray radiation, not infrequently proves to be successful in checking the development of the tumor, in intensifying the ossification, and establishing the recalcification process of the tumor itself.

As in the case of our patient, no operation short of an amputation could have been effective, owing to the fact that both the bones of the forearm were affected over a large area, we decided to apply roentgen therapy. The left forearm was radiated from different sides with roentgen rays after the so-called method of deep therapy. The dose applied to each field amounted to 175 r ($^1/_3$ H.E.D.), the number of fields being six. The general dose given was 2,100 r, or three H.E.D. After the very first radiation treatment, the pains which the patient had suffered for a number of years, ceased. He soon left the clinic feeling very fit. He has been advised to return to the clinic to have the treatment repeated.

VISUALIZATION OF THE BILIARY DUCTS BY MEANS OF GAS, FOLLOWING SPONTANEOUS DUODENAL ULCER RUPTURE[1]

By CHARLES GOTTLIEB, M.D., *New York City*

THE following case is instructive because the diagnosis was based entirely on the x-ray findings and also because it emphasizes the differential diagnosis between gas-filled ducts and the small intestinal loops.

The patient, R. Q., a Puerto Rican truckman, aged 34, entered the hospital complaining of severe epigastric pain of 15 days' duration, following an all-night drinking bout. The pain came on soon after eating any food, though his appetite was good. He complained of nausea during the first week and vomited during his first night in the hospital. There was no jaundice. He had lost some weight and was weaker since the onset of the attack. The pain was occasionally so severe as to interfere with sleep. Later there was no pain with or after meals. There was no hematemesis. There were no other symptoms except some dyspnea on slight exertion, fever, and night sweats on occasion.

His past history revealed that he had had syphilis eight years previously and an attack similar to the one above described two and one-half years before, at which time he had been at another hospital for 12 days.

Physical examination showed a man acutely ill. His pupils reacted to light and accommodation; his throat was congested and tonsils swollen and inflamed, especially on the left side; his tongue was moist and coated; the lungs and heart were negative. There was tenderness and rigidity in right upper quadrant so that liver could not be felt. The epigastrium was tender. There was an icteric tinge to the skin and the liver was enlarged about four fingers below the costal margin. Icteric index was 22. A month later, after treatment by duodenal drainage, the icteric index was 9. The van den Bergh test was negative and cholesterol estimation 150. Blood count showed a red cell count of 4,200,000; hemoglobin of 68 per cent;

Fig. 1.

white cell count 12,300, and 64 per cent polymorphonuclear leukocytes, and 1 per cent eosinophils. The Wassermann test was negative. Bromosulphthalein liver test showed no retention of the dye in the half- and one-hour samples of serum. The blood chemistry and gastric analysis were normal. Urine examination showed occasional pus cells. The spinal Wassermann, eye-ground, and Widal tests were negative.

An x-ray examination of the urinary tract, made about a month after admission, failed to show evidence of calculus. The heart and lungs were examined a month later but failed to show any pathologic changes.

[1] This is one of a series of papers contributed by friends and former pupils of I. Seth Hirsch, M.D.

The x-ray examination after a barium meal showed the stomach to be normal in size, shape, and position, with no filling defects. The duodenal cap was distorted and irregular. The terminal bile ducts were distended and filled with air; this was demonstrated on all the films. Examination at six and twenty-four hours showed no abnormality, except that the cystic, biliary, and common bile ducts were filled with air.

The x-ray examination after oral administration of the dye failed to visualize the gall bladder, but showed gas in the biliary ducts.

In view of the x-ray findings, the patient was transferred to the Surgical Service where, because of his poor condition, a transfusion was performed. The pre-operative diagnosis was duodeno-biliary fistula. Operation revealed a large abscess and a communication between the duodenum and the gall bladder together with a large ovoid mass, along the lesser curvature of the stomach, which was larger than a kidney and located in the lesser sac of the peritoneum. This was incised, pus suctioned off, and drains inserted. The patient steadily failed and expired.

On postmortem examination, another large abscess was found together with a duodenal ulcer of long-standing which had perforated into the gall bladder and thus visualized the biliary ducts.

Fig. 2.

Fig. 3.

LYMPHOGRANULOMA OF THE COLON[1]

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THE voluminous literature recently accumulated on the subject of venereal lymphogranuloma contains no specific reference to involvement of the supra-anal portions of the colon by this condition.

It is the purpose of this paper to describe three such cases complicating known rectal involvement: two in the transverse colon and one extensively in the descending and sigmoid.

History.—Copeland, as early as 1811, suspected the venereal origin of stricture of the rectum.

The condition was established as a definite pathological entity by the publication, in 1913, of a monograph by the Frenchmen, Nicolas, Durand, and Favre.

It remained for Frei, in 1925, to introduce a diagnostic skin test based on a specific skin reaction which immediately placed the differential diagnosis on a sound basis.

In 1930, the disease was transmitted to animals (monkeys) by intracerebral inoculations by the Swedish scientists, Hellerström and Wassen.

Levaditi later substituted the mouse as a more suitable animal for experimentation.

In 1932, Wolf, Sulzberger, and Wise introduced the cutaneous test in this country.

Etiology.—The disease is due to an unknown filtrable virus and its frequency varies directly with the degreee of sex hygiene rather than racial susceptibility.

Venereal lymphogranuloma is not related to granuloma inguinale, another venereal disease consisting of chronic, luxuriant ulcers produced by Donovan's bodies.

The disease produces definite systemic reactions such as fever, headaches, secondary anemia, hyperglobulinemia, high sedimentation rate, and anti-complementary Wassermann reactions, in addition to the long described local acute and chronic tissue responses.

Pathology.—Involvement of the colon grossly occurs by the formation of a granuloma and microscopically by the usual picture seen in a chronic non-specific granulomatous reaction, there being no pathognomonic pathological picture in this disease.

Pathogenesis.—The anatomical basis for the sequelæ of venereal lymphogranuloma of the rectum is mostly stasis due to the occlusion of the lymphatics by destruction of the lymph glands, resulting in ulceration, elephantiasis, and fistulæ formation which is responsible for the spread to the buttocks and other extensions upward, such as parametritis and peritonitis.

Roentgen Diagnosis.—The disease is manifested roentgenographically in the rectum by the demonstration of either extensive exudative inflammation, stricture, or fistulæ formation, depending on the stage of the disease. The changes higher in the colon are similar, and when found associated with known rectal involvement, must be considered as due to the same etiology. It is not the province of this paper to enumerate the clinical diagnostic criteria for the rectal diagnosis (history, controlled Frei tests, biopsy, etc.) but, whenever a case so labelled clinically shows an associated colon lesion and further shows reactions to the Frei therapeutic antigen, the etiology is self-evident.

At this point, we wish to describe the pattern of the colon mucosa assumed when involved by exudative inflammation of this or any other kind, that is, the Indenture Pattern.

The roentgenologic image is the shadow of a barium cast, the matrix of which is the intestinal lumen. Thus, the filling defect,

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best demonstrated with the distended colon, corresponds morphologically to the intraluminal contours of the lesion, while the extraluminal features are available only by inference from fluoroscopic controlled manipulation of the organ and sometimes by demonstration of the tumor mass itself on the film.

In 1933, one of us described the indenture pattern in a case of proven exudative inflammation of the appendix, obtained from a roentgenogram made of the barium-filled appendix.

Fig. 1. Indenture pattern of exudative inflammation.

Fig. 2. Case 1. Granuloma in the distal portion of the transverse colon.

The pattern is characterized by numerous indentures caused by swollen mucosal folds extending into the lumen (Fig. 1).

The defect has no sharp demarcation and the involved area gradually merges with the normal portions,there being an absence of the sharp crescentic borders seen in

neoplasms. The defects usually involve a larger segment than a neoplasm and may be multiple. In the acute stage, there is marked tenderness and intolerance to barium.

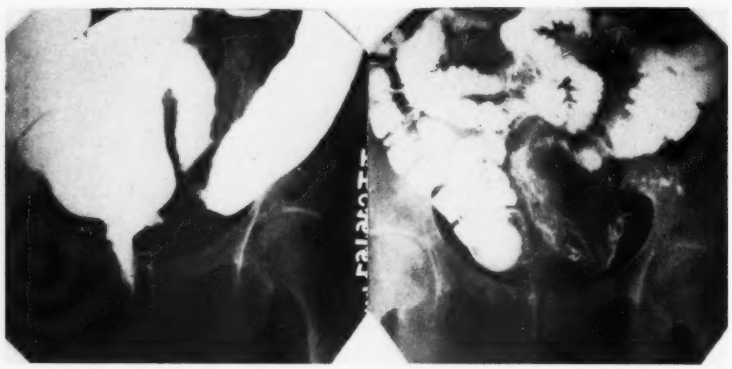

Fig. 3. Case 2. Rectal stricture and exudative inflammation of sigmoid and descending colon.

CASE REPORTS

Case 1. L. R., 22-year-old American negress, married, was admitted to the Kings County Hospital on Sept. 16, 1937.

Present History.—For the past two years, increasing weakness, shortness of breath, night sweats, a foul-smelling rectal discharge, dyschesia, blood-streaked feces.

Physical Examination.—Palpable inguinal glands bilaterally.

Rectal and Proctoscopic Examinations.—Entire rectum covered by ulcerating granulation tissue and firm and fibrotic to the touch. Sphincter thickened.

Laboratory Findings.—Urethral smear negative for gonococci; blood Wassermann, 2 plus (anti-complementary ?); Frei test controlled, positive three times; white blood cells, 10,750; polymorphonuclears, 71; lymphocytes, 24; transitionals, 5.

The abdomen was opened on Dec. 4, 1937, and a granulomatous pathologic process was found to involve the rectum and sigmoid for a distance of 25 cm. from the anal orifice. The involved area was removed by an abdominal-perineal operation and a permanent colostomy was made in the left lower quadrant. Enlarged peri-rectal lymph nodes and a small para-rectal abscess were encountered.

Microscopically, the tissue showed dense local infiltration with mononuclear cells. Nodules composed of epithelioid cells, lymphocytes, plasma cells, and occasional giant cells were seen. Many of the nodules were infiltrated with acute inflammatory cells and showed evidence of necrosis.

Pathological Diagnosis.—Lymphogranuloma venereum.

Post-operative Course.—Uneventful.

The patient was re-admitted to the Kings County Hospital in May, 1938, for pain in and around the colostomy wound. Barium examination *via* the colostomy on June 1, 1938, revealed a granuloma in the transverse colon (Fig. 2).

Case 2. A Porto Rican female, aged 38, sick for three years with diarrhea, constipation, dyschesia, and a foul rectal discharge.

Proctoscopic Examination.—Extensive rectal stricture with hypertrophy of the mucosa.

Biopsy.—Chronic inflammation with round cells associated with necrotic areas.

Frei Test.—Controlled, positive five times.

Wassermann Test.—Anti-complementary twice.

Roentgen Examination.—Revealed extensive stricturing of the rectum with fistulæ, associated with an exudative inflammatory reaction throughout the sigmoid and extending up to the descending colon (Fig. 3).

Treatment with Frei antigen resulted in a moderate increase in the patency of the rectum but no change in the exudative lesion in the sigmoid.

Case 3. White married male, aged 32.

Previous History.—Swollen inguinal glands three years previously which cleared up after incision and drainage. There was a recurrence of inguinal adenitis on March 17, 1938, while doing Frei tests.

Frei Test.—Controlled, positive five times.

Rectal Examination.—Revealed a stricture.

Proctoscopic Examination.—Showed stricture, thickening with ulcerating granulomatous plaques.

Biopsy.—Acanthosis of the epithelium. Infiltration of round cells and histocytes.

Barium Enema.—Revealed narrowing of the rectum associated with a large granulomatous lesion in the transverse colon (Fig. 4).

After treatment with Frei antigen subcutaneously and intravenously for about twelve injections, there was moderate improvement in the narrowing of the rectum and slight lessening of the extent of the granuloma in the transverse colon, as demonstrated on barium enema film.

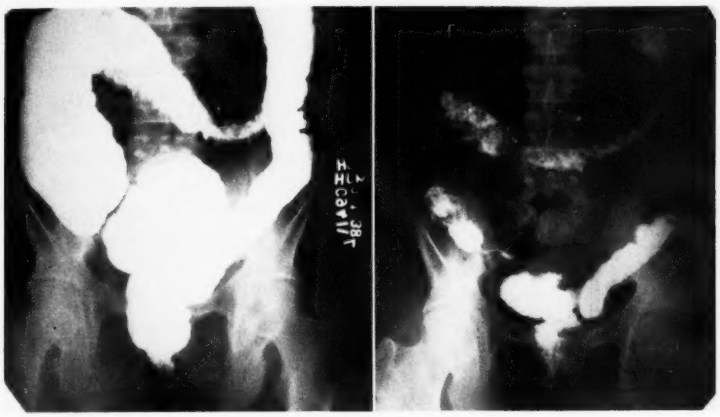

Fig. 4. Case 3. Extensive granuloma in the transverse colon.

CONCLUSION

Three cases exhibiting venereal lymphogranulomatous involvement of the rectum with additional associated involvement of the supra-anal regions have been described.

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THE RADIOLOGICAL EVIDENCE OF MALIGNANCY IN BONE TUMORS, AND ITS RELATION TO BIOPSY[1]

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IT has been abundantly shown that cure of malignant disease of the bone by any method of treatment is very rare, and that, like malignant disease in any other tissue, cure is dependent upon the early recognition of the localized metaplasia and its prompt eradication.

The development of a malignant tumor is insidious and in its early stages is not accompanied by any characteristic sign nor any prominent symptom; in fact, so indefinite may the latter be that the attention of the patient is not drawn to the site until the symptoms are aggravated by trauma or by the occurrence of a spontaneous fracture. Ultimately, the patient consults a medical practitioner whose suspicions may be aroused by the insidious onset of the lesion or the detection of a tumor or fracture. The practitioner is then faced with the question, what is the nature of the lesion.

Three lines of investigation are commonly employed for the purpose of answering this, *i.e.*, (1) conservative treatment—the development of the lesion being watched until it presents characteristic features; (2) surgical investigation and, if necessary, histological examination of excised tissue, and (3) radiography of the part. It is not unusual to find that all three methods have been adopted, and in this order, by the time the radiologist's opinion is sought and the lesion now appears clinically to be malignant or even inoperable. Under these circumstances, the radiologist will not be unduly anxious when writing his report for he will appreciate that he is adding but little evidence to that gleaned from the clinical examination.

Since the recognition that the chance of cure of malignant disease is dependent upon its early recognition, there has been a tendency to seek the radiologist's opinion at an earlier stage and with this a greater responsibility and a greater difficulty are thrust upon the radiologist. The knowledge needed for the recognition of a well-developed lesion having characteristic radiographic and clinical features can be readily acquired, but since many simple and malignant conditions present in their early stages radiographic appearances which are very similar—so similar, in fact, that one description may appear to portray all—considerable experience is essential for their early identification. Bone tumors, fortunately, are relatively uncommon in any one practice, but, unfortunately, as a result of this infrequency, the radiologist, unless he has made diseases of bones and joints a special study and for this purpose has established consulting contact with his colleagues, sees but a small number of such cases. It follows, therefore, that the average clinician who sees but a portion of the cases referred to the radiologist in any one area has a correspondingly reduced experience and must consequently appreciate the necessity for seeking and acting on the advice of such a consulting body as the American Register of Bone Sarcoma instead of depending on his own clinical judgment or radiographic interpretation. When advantage is taken of such consultative facilities, all available evidence should be submitted.

Procedure Advised.—When a patient reports to his or her doctor complaining of a localized pain or swelling which on clinical examination appears to be due to some lesion involving a bone, a radiographic examination should be made of the affected part.

The first radiographs may indicate to

[1] This is one of a series of papers contributed by friends and former pupils of I. Seth Hirsch, M.D.

the experienced observer either the nature of the lesion or the need for further investigation. If the radiologist consulted reports that the appearances are those of malignant disease, notwithstanding the fact that the clinical signs and symptoms may seem to be relatively insignificant, radical surgical measures should be promptly adopted. To wait until the signs and symptoms become so pronounced as to be recognizable robs the patient of the only chance of cure we yet know, or as the late Dr. J. C. Bloodgood tersely stated, "Less and less to-day are the clinical features of benign and malignant tumors of bone and of diseases of bone helpful in the diagnosis, but they should never be neglected. In former years when malignant disease could be recognized clinically there were no cures."

The details of the following case illustrate the necessity for the observance of the principles stated in the previous paragraphs.

Case 1. Miss X., aged 18 years, was referred to me for radiographic examination "to ascertain the present condition of a Brodie's abscess in the lower end of the humerus."

The history related by the patient at this visit was that some eight months previously, for no apparent reason or assignable cause, she began to get a dull pain in the elbow joint. She was given a course of radiant heat treatment. Two months later, she noticed the gradual development of a swelling just above the elbow joint and one month later radiographs were taken. The radiographs taken on this date showed a thin accretion of periosteal new bone and an alteration in the cancellous structure of about one inch of the lower end of the humeral shaft which was interpreted as a Brodie's abscess. This diagnosis agreed with the view held by the surgeon to whom she was referred and it was subsequently supported by another surgeon.

The patient told me that her previous health had been good: she had had no illness, no injury, and certainly had never had any septic focus. The lower area of the arm at the time of this examination presented a slight swelling above the elbow joint which was somewhat tender on pressure and was associated with restriction of the joint movements. The radiograph taken showed a further thin accretion of new bone extending over the lower one and one-half inch of the humeral shaft. The structure of this segment of the shaft showed further blurring of its cancellous architecture.

A report was given by me that the radiographic appearances were those of an endothelial myeloma and not a chronic inflammatory lesion, and amputation was advised. This was regarded by the surgeon as contrary to the clinical findings and a biopsy was performed for the purpose of draining the abscess. A fairly well-defined cavity was found in the bone and a quantity of pus-like material was evacuated, apparently confirming the clinical opinion. The material was submitted for bacteriologic and histologic examination and found to present the cellular characters of an endothelial myeloma. Yet, notwithstanding this confirmatory evidence of the radiological diagnosis, the clinical findings were permitted to dominate the issue and the question of amputation was waived.

A history such as that of Case 1 should not fail to impress an unbiased observer with the need for more enlightened cooperation between the clinician, the pathologist, and the radiologist. The positive findings of any one of these may be so characteristic to the observer who has made the subject a special study that the indefinite findings of any other investigation should not be allowed to dominate the treatment. And, though one might reasonably believe the clinician to be the one who should weigh up the evidence and on whose judgment the treatment should depend, it must be recognized that the clinical features at the early stage, when operative measures may possibly be successful, are so relatively insignificant that he must rely on the opinion of his specialist

colleagues. After all, they have had the same basic training as the clinician and there is no reason why they should be denied equal claims to assess the evidence produced.

Unfortunately, as we see from such histories as typified by Case 1, the clinician, who is always clamoring for earlier and yet earlier diagnosis, may reject the evidence supplied to him while he shelters himself from the execution of radical surgery under the plea that the clinical evidence is unconvincing, or seeks the refuge of radiation therapy, combating the possibility of future criticisms by the statement, "In any case, if it is so malignant, little benefit can be conferred by amputation." Nevertheless, when the lesion asserts itself in spite of radiation, he may be compelled to give relief of pain by amputation.

It may be thought that such criticism has no foundation, but, in support, I would refer to a statement made by a prominent orthopedic surgeon at a recent discussion on bone tumors to the effect that "there is no need for the pathologist or radiologist to lose one minute's sleep over the diagnosis of a bone tumor, for that is the province and responsibility of the surgeon." Such a statement leads me to wonder as to the nature of the responsibility such a surgeon is prepared to accept. Would the decision in a court of law where the evidence proved that the findings of experienced colleagues had been ignored be likely to influence him?

If the radiographic appearances are indefinite or atypical, further investigation is essential and must include a history of the development of the lesion and of the patient's previous health. The insidious development of a lesion in a bone of an individual who has previously appeared to have been in good health should be regarded as a very suspicious indication of neoplasm. On the other hand, if a history of previous inflammatory disease such as sepsis, pneumonia, scarlet fever, typhoid fever, or other exanthemas, suggests the possibility of the lesion's being of an inflammatory nature, this possibility must be first excluded.

Examinations of the blood picture and its serum reactions, the urine, and even the sputum may provide essential positive evidence. Unfortunately, there are cases in which in spite of all these investigations the nature of the lesion remains a problem. In such patients, the affected part may be immobilized and subjected at intervals, depending on the rapidity of the development of the lesion, to serial radiographic examinations until a decision can be made or a biopsy performed. By a study of serial radiographs alone, the nature of the tumor may ultimately be determined and this is the course frequently adopted in those cases presenting unconvincing clinical signs.

As the high degree of perfection which characterized the clinical examination prior to radiology did not permit of early diagnosis, it is unlikely that greater precision can be obtained to-day by this method when the clinician's attention is disturbed by the claims of the many auxiliary services. In the series investigated for this paper, the nature of the tumor was revealed before the clinical signs and symptoms were sufficiently advanced to permit of a clinical diagnosis.

Because the diagnostic features yielded by the clinical examination were so few and indefinite, attention was turned to histology, which provides a much higher percentage of accuracy, and the practice of a preliminary biopsy gradually asserted itself. To-day, biopsy is regarded by some as the primary essential investigation, and should the first biopsy yield material the histologic features of which fail to support the opinions already formed from the clinical features, a second or even a third biopsy is regarded as justifiable. It is interesting to note that in a number of the reported cases of osteogenic sarcoma which have been cured, two or more biopsies have been performed, yet in those cases of osteogenic sarcoma which present typical radiographic characters death has occurred from metastases in spite of the

performance of amputation without a preliminary biopsy. Yet we cannot infer from this that biopsy is a healing factor.

Histologic examination of material removed from some tumors and submitted to different expert pathologists will yield reports on the cellular structure ranging from simplicity to high malignancy. In the series which I have selected will be found examples of simple tumors which presented histologic characters indistinguishable from malignancy and which were interpreted as such (Figs. 5-*A*, 5-*B*, and 6); while in others, the histologic features of malignant tumors were interpreted as those of simple tumors (Figs. 1, 2, 3, 4, and 9). Such interpretations are due to the fact that identical cellular features are to be found in both simple and malignant tumors, and while the examination of multiple selected fragments may yield but one showing cells which are regarded as possessing malignant characters, this may rightly or wrongly be chosen to determine the diagnosis.

Errors in histologic interpretation may be due to the following factors:

1. Faulty selection of material. If the lesion is small and biopsy is decided upon, the focus should be accurately localized for the surgeon by the radiologist. In the case illustrated by Figure 9, the radiograph shows that the bone resected and reported as normal was removed from a site well away from the lesion in the bone: a later and more extensive biopsy provided material which established the malignancy of the tumor.

2. Insufficient data supplied to the pathologist. We know that x-radiation and other therapeutic measures may mask the malignant nature of the lesion, and the histology of callus at the site of a recent fracture may simulate malignancy.

3. Necrotic material may be mistaken from its macroscopic characters for pus. Any such material should be submitted for histological examination (see history of Case 1).

4. Failure to obtain the radiologist's co-operation. The radiologic features may be characteristic or indefinite. When the radiograph strongly indicates malignancy, a further examination of material regarded as of simple histology should be undertaken.

Unfortunately, there is evidence that biopsy may not only yield material which permits of error in interpretation, but which also causes local and possibly general dissemination of tumor cells. Serial radiographs of tumors before and after accidental or surgical trauma show marked acceleration and extension of the visible bounds of the tumor after the trauma (Figs. 1–4), and it is not unreasonable to believe that there is a relation between the trauma and the appearance of metastases in the lung a few months later. There is evidence that malignant metaplasia may occur at the site of a fracture of a bone which previously appeared to be free from such changes. I have seen such development occur in the broken end of one fragment, while the other fragment appeared to retain its normal characters.

When we come to consider the third method of investigation, namely, the radiographic, we realize that here we have a method which permits ready diagnosis of a large proportion of simple and malignant tumors without inflicting on the patient any additional discomfort, pain, or complications. Unfortunately, the nature of all bone tumors cannot be detected by the first radiographic examination, and it is more unfortunate still that it is generally in just these cases that the histological features are likely to be indeterminate.

The best radiographic technic to show the ultimate detail of the bony structure is essential. Radiographs of the opposite limb may be invaluable for comparison, and these should be scrutinized for signs of any defect or abnormality. Stereoscopic radiographs will sometimes give emphasis to small areas showing cancellous change which will escape attention in the ordinary radiograph. Particular attention should also be paid to the appearance of the soft tissues, as these may show changes before the bones.

It is most important that a complete radiographic record be made before any therapeutic measures are instituted. This applies in particular to x-radiation and radium therapy, for such radiation may completely mask the nature of the bone tumor. It can cause the most pernicious lesion to take on the radiologic and even the histologic characteristics of simplicity (Figs. 7-*A* and 7-*B*) or even normality, and by so doing rob the patient of the possibility of early diagnosis and treatment.

Notwithstanding all the possible fallacies following a thorough clinical examination, radiology must be the first court of appeal in all lesions of bone, for it is capable, in the majority of instances, of indicating to the experienced observer the pathology long before the clinical appearances can suggest it, and before surgical measures for biopsy or treatment are justifiable.

James Ewing says: "The whole clinical and radiological picture of the case of bone sarcoma usually furnishes a better conception of the diagnostic and therapeutic problem than can be obtained from a biopsy. Often the rate of growth, the extent of the disease, and the radiological details indicate the general nature and grade of malignancy of the process better than does the histological structure of the tumor, but this is not always the case. Few surgeons realize the limitation in the histological diagnosis of bone tumors and the conditions which simulate or accompany them."

If the radiographic evidence suggests that the lesion is simple and operable, surgical measures should be undertaken which will eradicate the lesion, for even such lesions as osteoclastomas, simple and multilocular cysts, exostoses, and chondromas have been seen ultimately to undergo malignant metaplasia. The bone removed should be submitted for histologic examination. If this confirms the benignancy of the tumor, the surgeon will be satisfied with the nature of the operation. If the histology suggests malignancy, though the radiology indicates simplicity, the case can be periodically examined for supporting evidence, and any further operative measures determined by this. Immediate amputation in such a case following a report of malignant histology is unlikely to increase the patient's chances and may be unnecessary. The histories of patients observed with typical malignant lesions in whom amputation followed on a biopsy suggest that the chances of cure are small.

From a careful examination of a large number of radiographs of cases which have been submitted for my opinion, I have made the following classification of the early radiographic signs of malignancy. In some of the cases the changes are already very extensive, but they represent the appearances shown at the first radiographic examination; presumably the clinical features previously had not been considered sufficient to warrant further investigation.

Malignant tumors of bone in the early stages present variable but characteristic radiographic features (Diagrams 1–5) which may be classified as follows:

1. Continued absence of any change in the structure of a bone or of its periosteal border which is included in a slowly progressive fusiform swelling of a limb. In the later stages, a thin layer of periosteal new bone may appear. Such features are found in the periosteal sarcomas of adolescents (Diagram 1). In the fibrosarcoma of adults, some irregular wisps of calcium may be shown in the tumor tissue and later, perhaps, localized peripheral erosion of bone.

2. An ill defined area of osteolysis near the diaphyseal extremity of a long bone—particularly the lower end of the femur and the upper end of the tibia or humerus—sometimes associated with a more or less well-developed spicule palisade periosteal cuff on the adjacent uneroded cortex (the height of the spicules diminishing from the edge of the eroded cortex), and sometimes with regular periosteal reaction and some increased density of the medulla adjacent and deep to the area of

osteolysis. A definite fusiform tumor of the limb over the lesion in the bone will be apparent (Diagram 2).

3. An ill defined area of uniform sclerosis, not the site of a chronic osteomyelitis, near the end of the diaphysis, spreading from the cortex into the medulla, often with a periosteal reaction of the palisade spicular type, but sometimes without very obvious periosteal newgrowth (Diagram 3).

4. An area showing diffuse change in the compact and cancellous structure which may be somewhat expanded and of increased density and often first brought to notice by a fracture after a relatively mild tumor (Diagram 4). The appearance may suggest the presence of a sequestrum in the latter case (Diagram 2-*C*).

5. Palisade spicules over a limited area of apparently intact cortex with perhaps general increase in the density of the underlying bone (Diagrams 5-*A* and 5-*B*).

The type of periosteal reaction varies considerably but its characters and associated bone changes are of diagnostic importance (Diagrams 5-*A*–5-*F*). It must be distinguished from that due to chronic inflammation and secondary neoplasm. These changes appear to be limited by the epiphyseal growth cartilage, so that the adjacent epiphysis and joint are not involved until the later stages.

The distinctive radiographic features of osteoclastoma, angioma, plasmocytoma, adamantinoma, chondroma, simple and multilocular cysts, and malignant metaplasia in Paget's disease of bone have been fully described in previous papers.

The histories of the following selected cases illustrate the more important points which I have tried to make in the body of this paper and its conclusions.

CASE HISTORIES

Case 2. P. T., male, aged 22 years, received a blow on the thigh while on

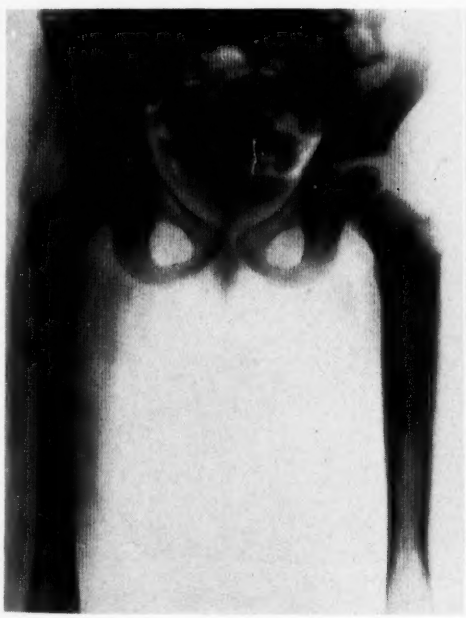

Fig. 1.

Fig. 2.

Fig. 1. Case 4. P. J., aged three years (July 8, 1935). Sarcoma of left femoral shaft. Before biopsy. No sign of tumor without the bone.

Fig. 2. Case 4. Three months later. Histology simple. Note broken irregular cortex with periosteal spicules and tumor of soft tissues. Deep therapy instituted. Patient died in May, 1936.

active service. A painful swelling, thought to be an abscess, followed. No pus was found on incision. A consulting surgeon made a diagnosis of aneurysm of the femoral artery. I was requested to make an exposure of the limb in the theater before operation. At operation no aneurysm was found, but some yellowish necrotic tissue was discovered and sent for histologic and bacteriologic examination.

Pathologist's Report.—"A mass of necrotic tissue of indefinite nature."

Bacteriologist's Report.—"Presence of *B. histolyticus*. Cultures injected into a guinea pig produced the characteristic slough caused by *B. histolyticus*."

The tumor, though incised in several places and irrigated with bactericidal fluids, continued to grow expansively, and protruded through the incisions, which failed to heal. Clinically, it had come to look like a typical sarcoma, but the bacteriologic findings obscured the issue. Radiographs at this stage showed a thin line of periosteal new bone formation

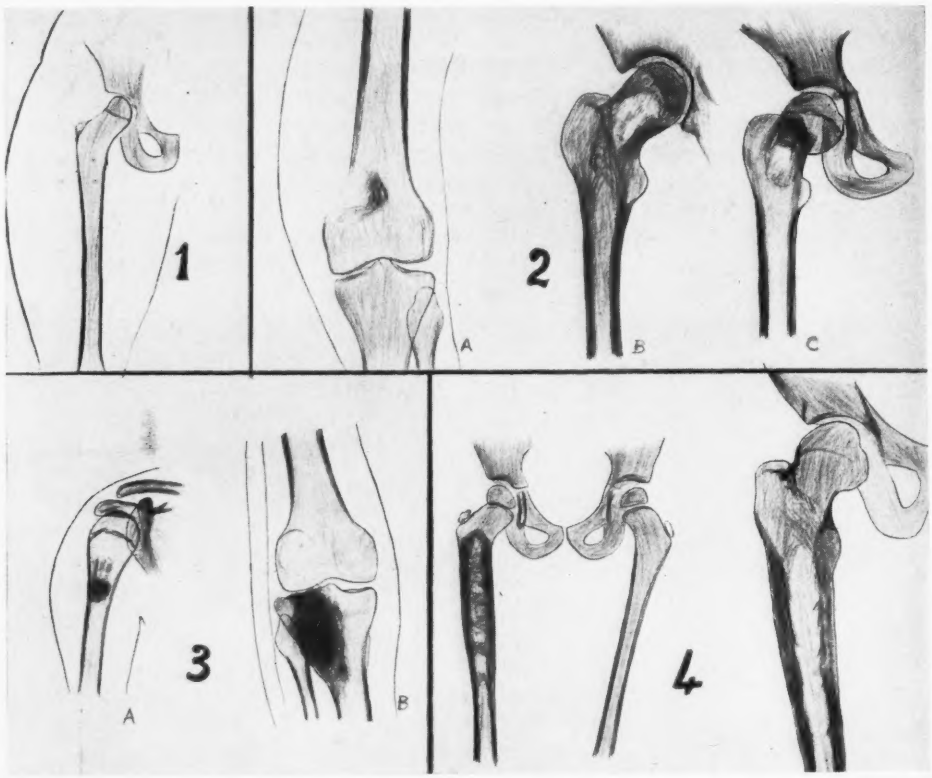

Diagram 1. Periosteal sarcoma in youth 22 years of age. Tumor of soft tissues—no bone changes.

Diagram 2. Osteolytic sarcoma (*A*) area of cancellous destruction in medial aspect of lower end of femur with sclerosis of adjacent deeper bone associated with fusiform tumor of soft tissues (male, aged 32 years); (*B*) ill defined area of cancellous destruction in femoral neck. No tumor of soft tissues to be detected; (*C*) pathological fracture of the femoral neck, area of cancellous destruction associated with a sequestrum-like denser fragment.

Diagram 3. Osteosclerotic sarcoma. (*A*) irregular ill defined areas of sclerosis in upper third of humeral shaft associated with fusiform tumor of soft tissues (boy, aged nine years); (*B*) irregular area of sclerosis of lateral half of tibial head (woman, aged 25 years).

Diagram 4. Ewing's sarcoma. (*A*) expansion of the proximal half of the femoral shaft which shows substitution of the normal compact and cancellous structure by a thickened sclerosed cortex having a regular periosteal margin but an irregular medullary margin and coarse irregular trabeculation of an expanded medulla (girl, aged three years); (*B*), similar type of tumor in boy, aged 16 years.

along the femoral shaft in the thickest part of the tumor; this was interpreted as evidence of septic periostitis, and may have been due to infection of the fungating tumor. Eventually, the limb was amputated at the hip joint, and when the tumor was examined macroscopically it showed the characteristic appearance of a periosteal sarcoma, a diagnosis supported by the histologic examination.

The patient made a good recovery, and after a short time was transferred to another hospital. A few weeks later an inquiry was received asking why this limb had been amputated, as the patient had shown marked improvement in general condition on anti-syphilitic treatment, the suggestion being that the lesion in the thigh had been a gumma. After a fortnight the patient died, and a postmortem examination revealed metastases of sarcoma in the brain and heart.

Case 3. Mrs. E. L., aged 48 years, in July, 1935, complained of swelling of the right calf which had gradually been increasing and had now become very painful. The patient said the swelling had been increasing for three months and pain had been present for the past fortnight.

On clinical examination there was a hard round swelling in the calf. A radiograph showed the swelling to be confined

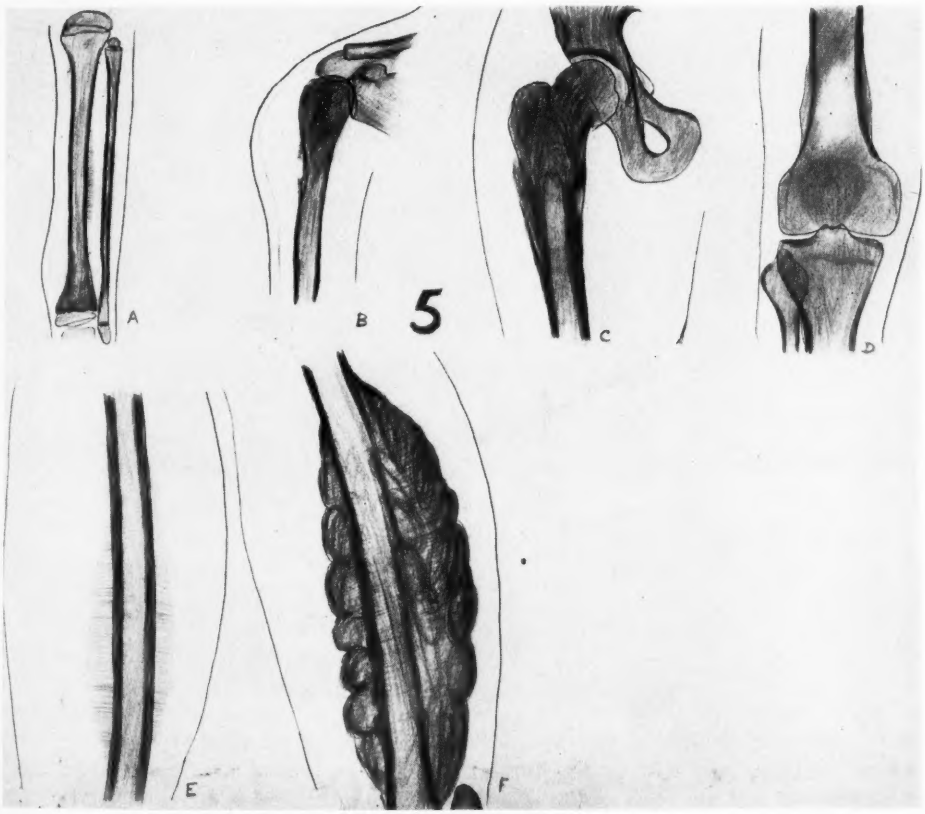

Diagram 5. Types of periosteal reaction associated with malignant tumor of bone. (*A*) palisade spicules associated with diffuse sclerosis of shaft and normal epiphyses; (*B*) periosteal cuff; (*C*) periosteal accretions; (*D*) regular periosteal thickening associated with central area of cancellous destruction; (*E*) palisade spicules with no definite changes in the compact and cancellous structure; (*F*) massive irregular periosteal new bone.

to the soft tissues; no change could be detected in the bone.

On Aug. 15, 1935, a large portion of the tumor was excised and submitted to an expert pathologist for histologic examination and report. It was hard and fibrous with a collection of material having the appearance of pus. On Aug. 22, 1935, the Wassermann reaction was recorded as 2 plus and the patient was put on a course of N.A.B. (novarsenohillon). The pathologist's report stated that the tumor showed the appearance of a fibrosarcoma, slow growing in type.

The patient made a rapid recovery and in September, 1937, all signs of the tumor had disappeared.

Case 4. P. J., a girl, born July 21, 1932, was brought to hospital on July 8, 1935, with a swelling of the left thigh. She had complained of intermittent attacks of pain in the left knee for some months: these were diagnosed and treated as rheumatism. On July 8, 1935, the radiograph (Fig. 1) showed expansion of the upper half of the femoral shaft with much thickening of the compact tissue and irregular sclerosis of cancellous tissue: one of the typical appearances of sarcoma. On Aug. 19, 1935, an exploratory operation was done and the surgeon reported the finding of a cavity and necrotic bone on the outer side of the shaft which he regarded as typical of a chronic inflamma-

Fig. 3. Fig. 4.

Fig. 3. Case 5. Miss K. M., aged 25 years (June 27, 1932). Osteosclerotic sarcoma of head of tibia before biopsy.

Fig. 4. Case 5. After three biopsies (July 20, 1933). Histology of first and second biopsy indicated a simple lesion. The third, a sarcoma. Deep x-radiation therapy was applied, but the patient died in May, 1934.

tory lesion. Portions were removed and submitted for bacteriologic and histologic examination and the report of an expert pathologist. No bacteria could be detected. The histologic report stated: "The material consists of bone spicules which are undergoing chronic septic inflammatory change. I can find no evidence of tuberculosis."

A radiograph on Oct. 15, 1935 (Fig. 2), showed that the thick compact layer had been decalcified in the upper third and largely replaced by fine radiating spicules typical of a sarcoma. On Oct. 15, the child developed a scarlatinal type of rash and was sent to the Fever Hospital. On Nov. 1, she was referred for deep x-ray therapy. On this date the child had a

A *B*

Fig. 5-*A*. Case 6. Miss W. K., aged 17 years (Sept. 18, 1928). Radiograph shows chondroma of the lower end of the fibula. Histology, chondrosarcoma.
Fig. 5-*B*. Case 6. October, 1937, nine years after resection. Good limb; no sign of secondaries or recurrence.

marked swelling of the upper half of the thigh and radiographs showed destruction of the normal architecture of the upper third of the femoral shaft which exhibited long spicules from the irregular periphery and below this, where the cortex was intact, a well-marked periosteal cuff. Three courses of deep x-radiation were given and a radiograph on March 10, 1936, showed considerable improvement in the radiographic appearances. The active appearance given by the fine radiating spicules had given way to a general ill defined sclerosis of the bone suggesting that the lesion was healing, but the child died within three months of metastases.

Case 5. K. M., aged 25 years, reported at the Royal Cripples Hospital June 27, 1932, with pain in the region of the knee joint. She stated that a year before she had fallen and injured her knee. The pain had gradually increased.

A radiograph on that date (Diagram 3-*B*, Fig. 3) showed an ill defined area of marked sclerosis of the outer half of the head of the tibia extending along the shaft for about three inches. There was a localized periosteal reaction over the affected bone but no swelling in the soft parts. The appearances indicated an osteosclerotic sarcoma. On Sept. 21, 1932, she was admitted to a general hospital.

The Wassermann test was found to be negative. The bone was exposed and a portion removed for histologic examination and the report of an expert pathologist. The report on the tissue removed read as follows: "The cellular structure suggests a chronic inflammatory condition rather than sarcoma. The sections show cancellous bone, the interstices of which are occupied by fibrous tissue with considerable accumulations of lymphocytes. A section of adjacent muscle shows dense fibrosis and occasional clusters of lymphocytes."

She was re-admitted in March, 1933, and a further histologic examination was made, the report of which states, "One part shows the appearance of osteitis fibrosa. The spaces between the bony trabeculæ are filled with fibrous tissue in which there is much round-cell infiltration."

She was re-admitted July 19, 1933, and the diagnosis of sarcoma was then made (Fig. 4), and x-ray treatment commenced on Aug. 3, 1933.

A letter which I recently received (dated January, 1937) from the mother in answer to my inquiry about the patient, states, "The trouble developed into a sarcoma and had a firm grip before anything could be done to save her life, other than by amputation. Kathleen decided to live her short time on this earth with both legs and she died on May 25, 1934."

Case 6. Miss W. K., aged 17 years, gave a history on Aug. 29, 1928, that seven years previously she had had an operation near the left ankle for an abscess. At that time there was much thickening of the lower end of the fibula and an adhesive scar which was diagnosed clinically as a chronic abscess of bone or osteomyelitis.

A radiograph (Fig. 5-*A*) was taken on Sept. 18, 1928, and showed a multilocular cyst-like expansion of the lower third of the fibula which I regarded as a chondroma.

The patient was admitted to the hospital, and in October, 1928, the tumor tissue was excavated from its bony shell and submitted to an expert pathologist for histological examination. The report ran, "Sections show the general structure of a chondroma with extensive myxomatous degeneration and large areas of necrosis. In places, however, the growth is very cellular and the cells are acquiring aberrant characters. I consider, therefore, that it must be regarded as a chondrosarcoma."

Good healing rapidly took place and in November, 1928, the patient was told to discontinue treatment and wear ordinary shoes, and in January, 1929, was given permission to resume work. Serial radiographs showed a progressive consolidation of the excavated area and in October, 1937, the limb appeared to be normal and the radiograph showed complete consolida-

tion and no evidence of any extension (Fig. 5-*B*).

Case 7. Mrs. M. B., aged 34 years, began to complain of pain in the back, in 1929. Early in 1931, she was ordered a posterior support to the back and treat-

Fig. 6-*A*, *B*, *C*, *D*. Serial radiographs showing an osteoclastoma of the lower end of the tibia which was curetted from the bone and submitted for histologic examination. Report, fairly cellular fibrosarcoma. *B*, *C*, and *D* show subsequent consolidation without any further treatment. The patient has a useful leg and no evidence of recurrence.

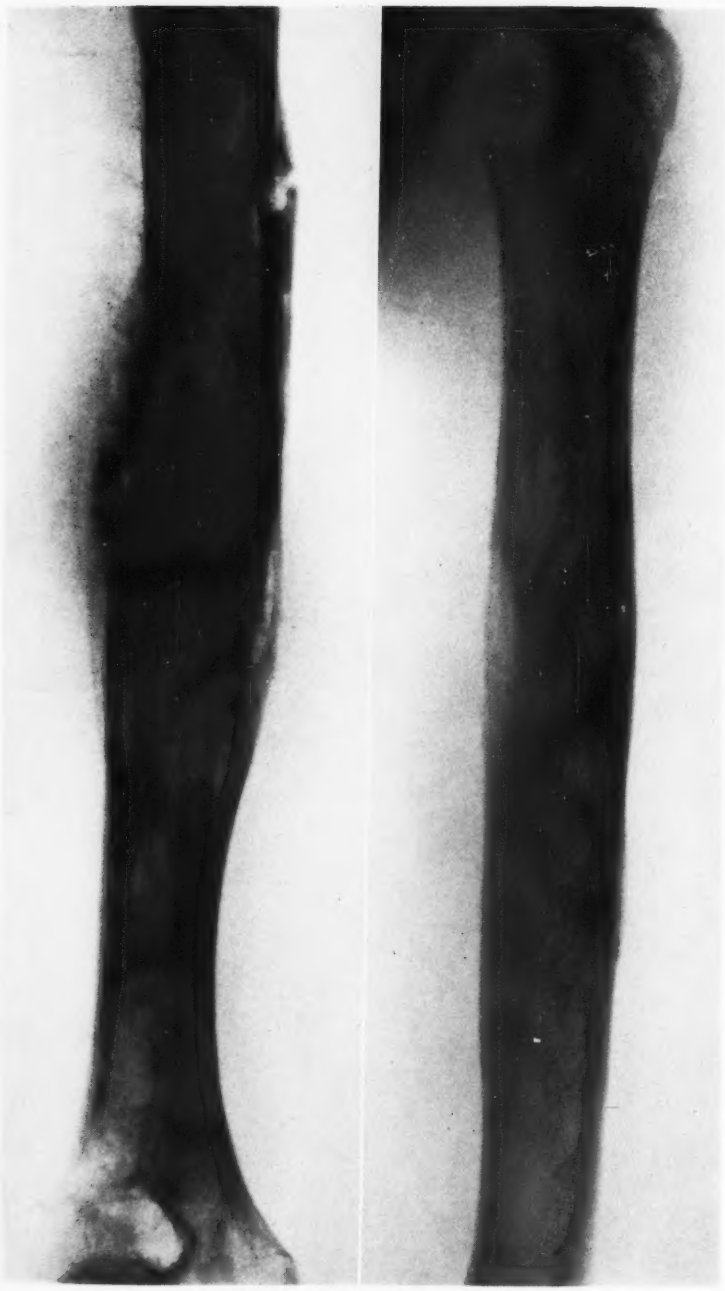

Fig. 7-*A*

Fig. 7-*B*

ment in recumbency. In November, 1931, a psoas abscess was discovered on the left side. This pointed in February, 1932, and was aspirated. Radiographs showed caries of the second lumbar vertebra with destruction of the disc between the second and third lumbar vertebræ. Treatment continued in recumbency until January, 1933. In April, 1933, patient complained of pain under the right heel and this was found to be tender. The pain in the ankle continued and in September, 1933, a radiograph (Fig. 6) was ordered. This showed a destructive tumor at the lower end of the tibia which I reported on as an osteoclastoma.

In October, 1933, the tumor was evacuated from its bony shell by curetting and a portion of the tumor was sent for a report by an expert pathologist. This read, "This has the structure of a fairly cellular fibrosarcoma with small areas of ossification. A few multinucleated cells of the type of osteoclasts are present but the tumor has not the appearances of a myeloma."

An iron support was fitted and the patient has continued to use this. Serial radiographs to the present day (October, 1937) show a progressive consolidation of the evacuated area with marked density of the new bone (Fig. 6): no evidence of any recurrence or extension. Clinically, the ankle is to-day sound.

Case 8. Mr. B. R., aged 18 years, complained on Jan. 21, 1933, of pain in the region of the right knee joint when he walked; there was no pain on lying down. He had walked with a limp for the past four or five months. On examination nothing was found except some wasting of the right quadriceps and calf muscles. No tenderness was noted on pressure over the bones. Patient pale and thin. Patient was sent for x-ray examination with the presumptive diagnosis of tuberculosis of the hip joint. The radiologist reported, on Jan. 26, 1933, "Changes in cancellous structure of the upper third of the femur with laminated periosteal accretions of new bone indicating a malignant tumor, probably endothelial myeloma. There were no abnormal shadows in the lung-fields."

On Feb. 9, 1933, the bone surface was exposed and found to be irregular and abnormally soft. In the opinion of the surgeon the appearance and characters suggested a chronic inflammatory lesion. A portion was removed and submitted for the report of an expert pathologist's histologic examination. The pathologist's report on Feb. 21, 1933, was, "Section shows osteitis fibrosa with areas of edema, vascular thickening and collection of lymphocytes. No evidence of tumor."

The patient was discharged on March 10, 1933; the wound was healed and pain relieved.

At my request the patient reported at hospital on May 3, 1933, at which time he complained of pain in the left side and arm. The pain was very severe, coming on in sharp attacks which gradually subsided in the course of half an hour if he kept quite still. On examination a swelling was seen over the upper left ribs. Some swelling over the right trochanter suggesting displacement of the right hip joint with one-half inch of shortening. Radiographs showed an opacity in the upper right lung-field with destruction of the second and third ribs, and an opacity of the lower left lobe with erosion of the eighth and ninth ribs. There were areas of destruction also in the clavicle and the right ilium. A course of x-ray therapy was commenced immediately. The patient died in August, 1933.

Case 9. A boy, aged three years, was radiographed on June 23, 1923, to ascertain the nature of a tumor in the lower

Fig. 7-*A*. Sarcoma of the humeral shaft (Ewing) of a youth, aged 16 years (Dec. 14, 1932), showing disorganization of structure and irregular periosteal spicules.
Fig. 7-*B*. Same as 7-*A* (July 27, 1935) after x-radiation therapy. Note the disappearance of periosteal spicules and considerable reorganization of shaft. The patient died in December, 1936.

A *B*

Fig. 8-*A*. Case 10. Miss N. H., aged 17 years (June 21, 1937). Radiograph shows well defined area of destruction in lateral epicondyle of humerus with central sequestrum.

Fig. 8-*B*. After removal of sequestrum and curetting of cavity wall.

third of the leg. The radiograph showed expansion of the lower third of the shaft of the fibula with irregular cyst-like excavation of the lower half of the expansion. The lower third of the tibial diaphysis showed marked bowing and excavation of the lateral surface with irregular sclerosis and areas of cancellous destruction in the lower two-thirds of the diaphysis. These appearances suggest a chondroma. A segment of fibula was removed, and the pathologic report dated Nov. 1, 1923, stated, "This has the characters of an ossifying chondrosarcoma." Amputation was refused by the parents, and the patient is now perfectly well (1938). There has been no recurrence; the limb is sound.

Case 10. Miss N. H., aged 17 years, a typist, came to hospital on June 21, 1937, complaining that she had had an aching pain in the region of the right elbow for six months. There was no evidence of any injury. The elbow began to swell a little about two months previously and the movements of the joint became limited. X-ray examination on June 21, 1937, revealed a well defined rounded cyst-like area in the external condyle of the humerus which has a sequestrum-like body within (Fig. 8-*A*). The radiographic appearances are suggestive of a bone abscess, probably tuberculous.

The area was explored on July 2, 1937. The cavity was exposed and a free rounded bony body was removed from within and the walls of the cavity were curetted.

The curettings and bony body were sent for histologic examination and the report of an expert pathologist. The report read, "Sections taken from the scrapings from the wall of the cavity have the structure of a calcifying chondrosarcoma. The sequestrum itself consists of calcifying cartilage but the peripheral part is more cellular and must, in my opinion, be regarded as a chondrosarcoma."

The wound healed by first intention and the pain and discomfort largely disappeared. A radiograph taken July 6, 1937, showed the well defined round excavation in the external condyle (Fig. 8-*B*). There was no evidence of any extensive or surrounding reaction. Progress in the clinical improvement continued and the symptoms ceased to cause discomfort.

On March 29, 1937, the limb was amputated at the junction of the middle and upper thirds of the humerus. Macroscopic examination of the sectioned amputated limb showed a cavity with a little hemorrhagic reaction spreading in the bone in some areas about one-eighth inch deep. In one small area decalcification had occurred. Sections from one piece of this fibrous wall revealed typical simple fibrous tissue, whereas the further fragment contained in the small area of decalcification showed sarcomatous characters. In October, 1938, there was no sign of recurrence, nor had metastases yet been detected. The patient appeared to be in good health.

Case 11. G. H., aged seven years, was brought to hospital on June 24, 1937, complaining of pain in the left hip which caused her to limp. This had been continuous since she was knocked down in the playground at school.

On examination she was found to have a temperature of 101°. There was no gross swelling of the soft tissues but there was tenderness over the great trochanter and for some distance down the lateral aspect of the femur.

An x-ray examination was requested and the radiographs (Diagram 2-*C*), which show one of the typical appearances of sarcoma at this site, were interpreted as showing extensive periostitis with osteomyelitis of the neck of the femur and upper part of the shaft.

On June 28, 1937, a vertical incision was made on the lateral aspect of the thigh over the great trochanter. The bone was exposed and an incision was made into it. A portion of cortex was removed and a record was made that this showed granulation tissue on its deep aspect. This material was submitted for a report by an expert pathologist.

On July 1, 1937, the report from the pathologist stated that no tubercle bacilli or other organisms were found by direct examination or in cultures.

Fig. 9. Ewing sarcoma in boy 16 years of age. Note diffuse changes in the upper third of the femoral shaft with resection of a small square fragment of bone below this which had normal histology.

On July 6, 1937, the report of the histologic characters read, "A large part of this material is necrotic with areas of hemorrhage undergoing organization. There is nothing suggestive of tuberculosis. In some parts there are small masses of cellular tissue which, in my opinion, have the appearance of a sarcoma. In view, however, of the extensive necrosis, I do not feel justified in making an absolute diagnosis, but I think that the case should be further investigated from this point of view."

A radiograph taken a fortnight after the operation showed extensive destructive growth of the sarcomatous tissue. Serial radiographs during the next three months demonstrated a progressive sarcomatous destruction of the femoral shaft and, in spite of a course of deep x-radiation with recumbency, the femoral shaft fractured and the child rapidly lost ground, developed multiple metastases in the lungs, and died.

Case 12. Mr. R. L., aged 31 years, came to hospital on Dec. 6, 1936, complaining of pain in the right knee which was swollen and gave difficulty in walking. He stated that he had recently had a severe wrench to his knee and that nine years previously he had had a blow on the knee with a cricket ball.

He was treated for three weeks with Scott's dressing and the swelling subsided. It recurred but again subsided following an application of Scott's dressing.

He was sent for an x-ray examination on Jan. 6, with the presumptive clinical diagnosis of early osteo-arthritis of the knee joint. The radiographs (Diagram 5-*D*) showed abnormal appearances in the lower third of the femur and I reported, "There is a central area of cancellous destruction with periosteal new bone formation in the lower third of the femur suggesting a Brodie's abscess, but the changes are not absolutely typical of the latter. No changes in the subarticular bones of the joint."

A week later the area was explored and the notes stated that about three ounces of pus were removed. Some of the material was submitted for the examination and report of an expert pathologist, who reported that the appearances suggested sarcoma.

In this case the histologic characters were so definite that I felt no hesitation in advising the surgeon to act on this

evidence, though I could find no evidence of secondaries in the lungs.

The limb was amputated, but within a few weeks multiple metastases were demonstrated radiographically in the lungs.

Case 13. Mr. J. B., aged 29 years, fell down on Dec. 1, 1935, and bumped his knee. On examination at the hospital a few days later, the knee was so swollen and painful on the inner side that he could not walk. Practically no movements of the joint could be made; it was apparently fixed. The pain was so severe that the patient had been unable to sleep since the accident. The clinical appearances of the limb and joint at this time suggested old tuberculous arthritis, and in support of this the radiographs showed a degree of osteoporosis and the patient gave a nine and one-half years' history of disability which had seemed to follow an injury. The limb was put into a plaster for five months and during this time the patient experienced little trouble.

He reported again May 1, 1936, complaining of increase of pain and swelling. A radiograph made May 3, 1936, showed general osteoporosis of the bones entering into the joint and an ill defined area of cancellous destruction in the femoral condyles and the tuberosity of the femur.

On Nov. 3, 1936, he was again admitted with great pain and swelling of the knee joint. It now exhibited some fluctuation on the medial aspect. It was very hot, tender, and its surface was injected and nearly double the size of the normal knee joint.

A radiograph, on Nov. 4, 1936, showed an increase in the osteoporosis and in the size of the areas of cancellous destruction and a small area had now developed in the patella.

Arthrodesis of the knee joint was decided upon. The knee joint was opened and within its capsule was found a large collection of semigelatinous pinkish friable material which was cleaned out. The articular surfaces of the bones were sawn off and similar material was found to occupy the shells of the bony extremities. These were curetted and the bony extremities brought into apposition with wires.

Histologic examination of some of the material removed showed a cellular malignant tumor which Professor Haswell Wilson reported to exhibit "the characters of an endothelioma which had probably originated from the synovial membrane."

A few days after operation, a radiographic examination of the chest revealed multiple secondaries somewhat smaller than peas.

Case 14. Miss D. W., aged 26 years, reported at the hospital April 9, 1937. She gave a history of pain in the left leg which began in August, 1936. She now had little pain but a definite limp. Her general condition was good but there was some atrophy of the muscles of the left buttock, thigh, and calf. The left knee jerks were brisk.

No other abnormality was found in the chest, abdomen, or other limbs but there was a history of recent hematuria associated with stones in the bladder.

Mr. F. G. Allan's report at this stage stated, "This case is one suspicious of disease of the lumbo-sacral and sacral joints or thereabouts and the paralysis of the leg is secondary to some external involvement of the nerves, either in the pelvis or just above their exit from the vertebral column. There is also a confused history of bladder stones which may have some bearing on the condition. Whether the condition is tuberculous or not I cannot say definitely without x-ray examination, but, in any case, she should be admitted to the Woodlands Hospital as quickly as possible."

On admission to the hospital, it was found that she was unable to move the left foot. The knee jerks were very brisk. There was no sensation in the left foot and a burn of the third degree was present on the dorsum.

X-ray report (Fig. 10) on Oct. 18, 1937, stated: "Stone in bladder. Destruction of the upper sacral bodies and the body of the fifth lumbar vertebra. The destruc-

tive process has progressed considerably. I am of the opinion that the lesion is of a neoplastic nature and should advise a trial of deep therapy be given without biopsy."

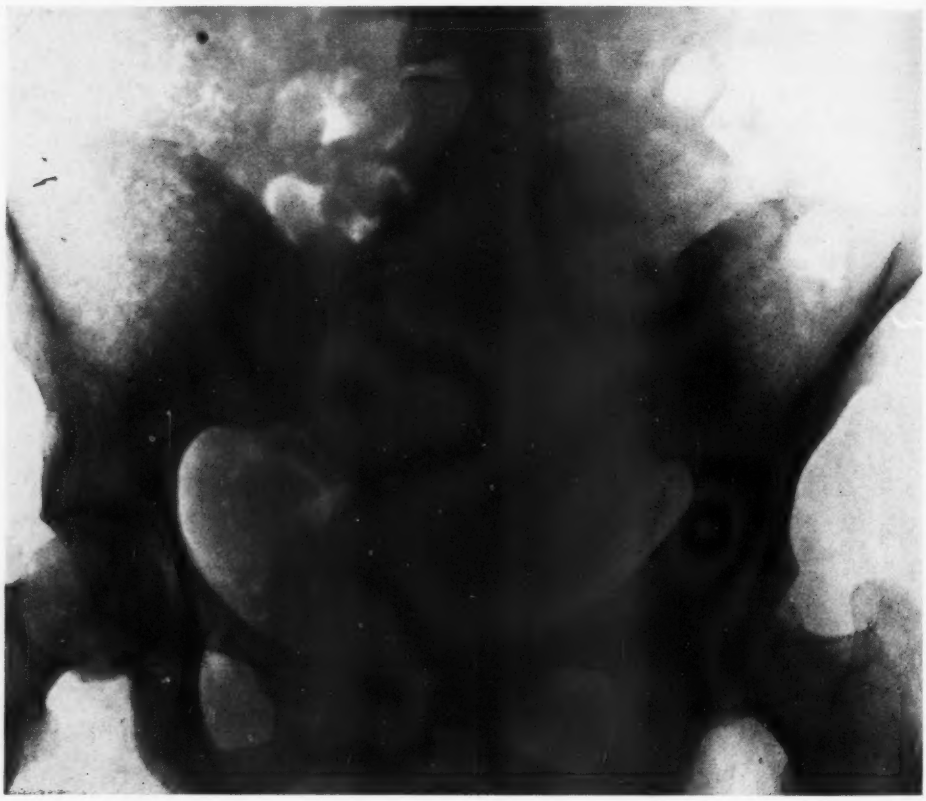

Fig. 10. Case 14. A chondroma destroying the sacrum and fourth and fifth lumbar vertebral bodies, in a female 26 years of age.

A fluctuating swelling was explored with a needle but only a small quantity of blood was withdrawn.

On Oct. 26, 1937, the case sheet for the day recorded that the patient was feeling rather unwell and looked ill. Six ounces of pus were passed per rectum.

In December, 1937, a biopsy was made and the histologic report was that of chondroma. X-radiation was given.

Radiographs made in October, 1938, showed that there was some general increase in the destructive process.

CONCLUSIONS

1. The most important decision to make in the diagnosis of a bone tumor is whether the lesion is simple or malignant. In most cases, radiography affords the earliest and most useful information for this purpose without disturbing the patient or the lesion.

2. Few patients are presented for radiographic examination in the very early stages, for they appear to be in good health and apparently the clinical signs do not suggest to the clinician a lesion serious enough to warrant an x-ray examination.

3. Simple tumors of bone present characteristic radiographic appearances

which permit of their identification by the experienced observer.

4. Malignant tumors of bone in the early stages present variable but characteristic radiographic features.

5. The recognition of one of these typical appearances should be followed by an x-ray examination of the lungs and pelvis for the demonstration of possible metastases. The possibility that the bone lesion may be a metastasis from a primary carcinoma elsewhere should be considered.

6. No treatment should be administered until a complete radiographic record has been made. X-radiation when first applied tends to obliterate the evidence of malignancy in some cases.

7. When the lesion is malignant according to radiological examination and apparently operable, amputation should be performed as early as possible—it provides the best chance of cure we yet know. A prior biopsy merely to obtain histologic material would not help because it would accelerate the development of the local growth even if not the dissemination of metastases and provide material the histologic appearances of which may be misleading.

8. When from the radiologic examination the lesion appears simple and operable, surgery is indicated as the first line of action, local resection or curetting is indicated according to the operative findings. Malignant metaplasia has been recorded in several so called benign tumors and other simple diseases of bone. The pathological tissue removed should be histologically examined and the case kept under observation, particularly if the pathologist suggested that the lesion was malignant.

9. When, according to radiographic or clinical examination, the lesion is inoperable, even though it appears to be non-malignant in character, radiotherapy or other non-surgical measures should be tried. Biopsy in such cases can serve no useful purpose and may introduce still further unpleasant complications on the unfortunate patient.

10. When the lesion is radiographically atypical, it should be immobilized (for trauma can only do harm) and studied by serial radiographs for a few weeks or months, depending on rapidity of change, while in the meantime the Wassermann reaction, blood and urine examinations are performed. If the lesion continues to extend and its nature remain indefinite, the chest and pelvis should be radiographed and, if negative, the effect of a moderate dose of radiation may be tried. If this is unsuccessful, resection or amputation should be performed according to the clinical and radiographic indications, and the material so obtained should be submitted for histologic examination.

Unfortunately it was in this group of cases that the histology was often difficult to interpret.

11. Only a small proportion of tumors of bone respond effectively to radium or x-radiation. As it is slower and less certain than amputation, it should be reserved for the inoperable and doubtful cases. A tumor which will respond effectively to such radiation will not require that the treatment be extended to its limits: to do so renders the patient liable to burns so painful that amputation for relief may be necessary even though metastases may be radiographically demonstrable.

12. Radium and x-radiation do not prevent the dissemination of metastases even though the primary tumor appears to have so favorably responded that the bone has practically recovered its normal appearance.

13. If biopsy is decided upon, the lesion should be accurately localized by radiography to ensure that histologic material is obtained from the right place.

14. If material which has the macroscopic appearance of pus is found, this should be subjected to histologic as well as bacteriologic examination, because necrotic material in some malignant tumors presents this appearance and has led to the error of diagnosing an osteomyelitis.

15. The histologic appearance of a tu-

mor and the tissue in its immediate vicinity are affected by radium and x-radiation therapy, trauma, infection, etc. Therefore, it is essential that the histologist should be informed of any therapeutic and surgical measures that have been employed and of their nature.

16. In view of the fact that identical histologic characters may be found in both simple and malignant tumors, classification by histology is liable to be misleading.

17. Only 5 per cent of some 1,500 cases of sarcoma registered by the American Registry of Bone Sarcoma were alive at the end of five years. This number I believe to be within the margin of error in diagnosis. Every case of unquestionable sarcoma I have seen on whom a biopsy was performed died within a few months. I have seen several cases which presented radiographic characters of inoperable neoplasm on whom no biopsy was performed and who were apparently cured by x-radiation. I have seen several cases having the radiographic characters of simple tumor which were treated surgically as such, *i.e.*, by curetting or resection, and, though histologic examination by expert pathologists of the material removed indicated malignancy, the subsequent clinical history of 16 years in one case proved the simplicity of the lesion.

18. It is impossible to judge of the malignancy of a tumor of bone by clinical examination at a stage when operative treatment is of any avail.

19. Good quality radiographs and a carefully taken clinical history are essential.

20. Co-operation between clinician, pathologist, and radiologist is essential for the best results.

TELEOROENTGEN KYMOGRAPHY

ITS APPLICATION TO THE STUDY OF HEART SIZE, OUTPUT, AND AORTIC ELASTICITY[1]

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THE development of multiple slit roentgen kymography has provided a simple method for graphically recording the movements of the heart, which has yielded much information of physiological and clinical interest.

The movements of the various chambers throughout the cardiac cycle, recorded in the form of a wave, are characteristic. The ventricular waves bear a close resemblance to experimental curves of ventricular volume changes. Zdansky and Ellinger (1), impressed by the close correspondence, regarded the kymographic wave of the left ventricle as practically a pure volume curve, and with restrictions accepted differences in amplitude of the wave as an index of changes in stroke volume. Johnson (2) found a close correspondence between the amplitude of the kymographic ventricular wave and stroke volume determined by the dye method.

The change in cardiac contour which the kymogram records is not purely a volume change however, but is a resultant of the predominant contractile thrust, of rotary movement, and of positional changes of the heart as a whole. The greatest objection to any quantitative interpretation of the kymographic waves is that until now kymograms have generally been taken at about a thirty-inch distance. Due to magnification of the image resulting from the shortened focal distance, no valid conclusions concerning heart size and its changes could, therefore, be drawn.

Teleoroentgenographic distance has not been attained hitherto because of the high energy factors required of the x-ray tube. In the first of his contributions on roentgen kymography, Hirsch (3) stated, in discussing technic: "The ideal arrangement would appear to be a very narrow slit, a high speed of film movement, and a long focal distance. But the smaller the slit, the faster the movement, the longer the distance, the greater would be the intensity of radiation necessary to make a satisfactory kymogram at a two-meter distance. Thus, with 0.4 mm. slits and 1.2 cm. per second film speed, it is necessary to energize the tube with 300 ma. at 100 kv. over a period of one second for a distance of 200 centimeters. It is apparent, therefore, that at present technical limitations to the production of the ideal kymogram exist."

TABLE I

Authors	Slit Width	Rate of Film Movement (Mm./Sec.)	Total Exposure	Equivalent Single Exposure	Distance
Goett	3 mm.	17	3.5 sec.	1/6 sec.	50 cm.
Crane	2	50	1	1/25	60
Knox	2	6	8	1/3	?
Stenstrom and Westermark	1	20	2	1/20	75
Stumpf	2	50	2	1/25	80
Stumpf	0.5	4	3	1/8	100
Cignolini	3	50	11	1/17	95
Delherm	0.5	6	2	1/12	75?
Hirsch	0.4	12	1	1/30	100
Ungerleider and Gubner	0.4	8	1.5	1/20	200

[1] This is one of a series of papers contributed by friends and former pupils of I. Seth Hirsch, M.D. Submitted for publication Nov. 1, 1938.

The kymograph employed by Hirsch fulfilled these conditions more closely than any apparatus constructed up to that time. Table I, taken from Hirsch's articles (3, 4), summarizes the technic used by various investigators. The factors employed in our study are appended.

Hirsch's kymograms were taken with 87 kv. and 100 ma. for an exposure of one second, at 100 cm. Teleoroentgenographic distance has been made possible in our studies by the use of a tube of sufficiently high capacity, energized by a three-phase generator, which tends to maintain an almost even potential near peak value: 180 ma.-sec. at from 60 to 85 kv., depending on the thickness of the chest and the obliquity of exposure, were employed for from a one to one and one-half seconds exposure. Teleoroentgen kymograms obtained with this technic are of excellent photographic quality, with sharp contrast.

The measurements of the teleokymogram correspond precisely to those of the regular teleoroentgenograms (Figs. 1, 2). Figures 3 and 4 illustrate two kymograms of the same subject, one taken at teleoroentgenographic distance, the other taken on another kymographic apparatus at about a thirty-inch distance. It is readily apparent that there is appreciable magnification due to the shortened focal distance.

The teleoroentgen kymogram thus provides an accurate image of the heart and its movements. Some three hundred and fifty kymograms have been taken by this method thus far, consisting for the most part of normals in various age groups, with a smaller number of pathologic cases. In this preliminary communication, no attempt will be made to analyze this large series. We wish only to suggest its possible application to the determination of heart size and output.

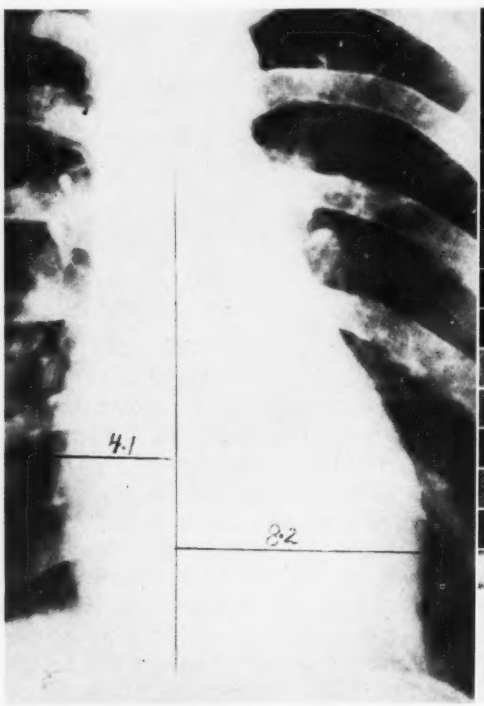


Fig. 1.

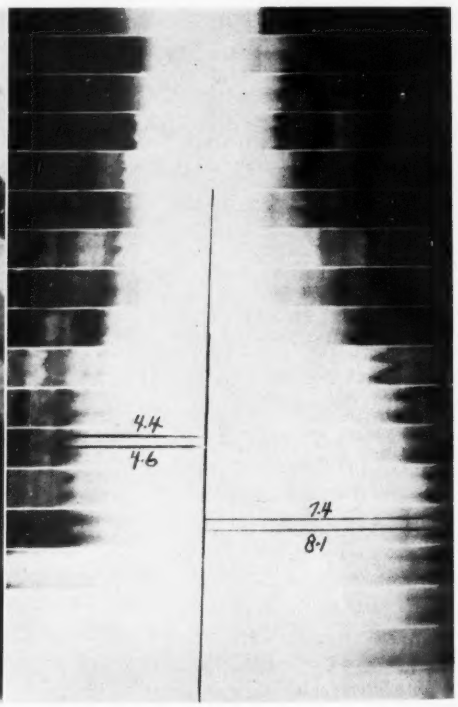


Fig. 2.

Fig. 1. Teleoroentgenogram of normal subject. Transverse diameter, 12.3 cm.
Fig. 2. Teleokymogram of same subject as shown in Figure 1. Transverse diameter: systole, 11.8 cm.; diastole, 12.7 cm.

Although the cardiac output is one of the fundamental units of the circulation, it has been neglected in clinical medicine because of the difficulty in measuring this function. The direct Fick method is not applicable in man. The various gasometric methods (acetylene, ethyl iodide, nitrous oxide, etc.) require elaborate preparation and tedious analysis and their accuracy has frequently been questioned in heart disease in which the estimation of cardiac output is of greatest interest (5). Difficulty of technic also precludes any widespread use of the injection method of Hamilton, Moore, Kinsman, and Spurling (6), since arterial puncture is required. The determination of cardiac output indirectly from physical measurements based on fundamental circulatory factors has been attempted, notably by Broemser and Ranke (24), Wezler and Boger (26), and by Bazett and others (29).

Harrison (7) and others (8-*a*, *b*) have found that the minute output of the heart is not usually greatly reduced even in severe cardiac decompensation, and so this measure alone gives little clue to the functional condition of the heart (20). The ratio of stroke volume to heart volume, however, is a direct expression of the efficiency of the heart in accordance with Starling's law. The significance of this ratio has been recognized and studied by Benedetti (8-*a*) and by Lysholm, Nylin, and Quarna (9). Nylin (10) has established standard normal ratios of heart volume/stroke volume, and has found this ratio to be of great practical importance as an expression of the functional state of the heart; an increase of the ratio heart volume/stroke volume betokens impaired cardiac reserve.

While roentgenologic attempts to determine heart-volume changes (stroke volume) from systole and diastole exposures have been criticized on theoretical grounds, they have the advantage of providing at the same time an expression both of heart

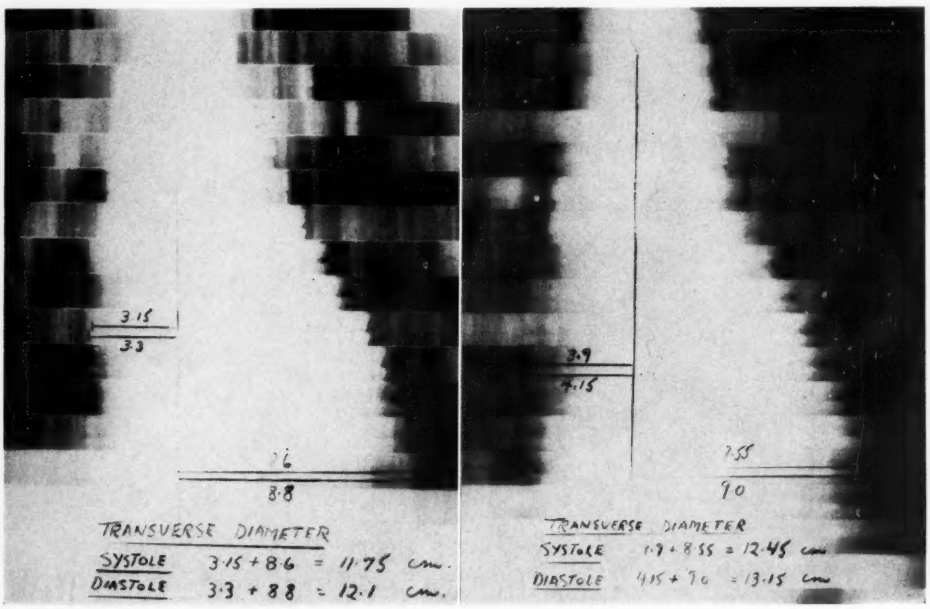


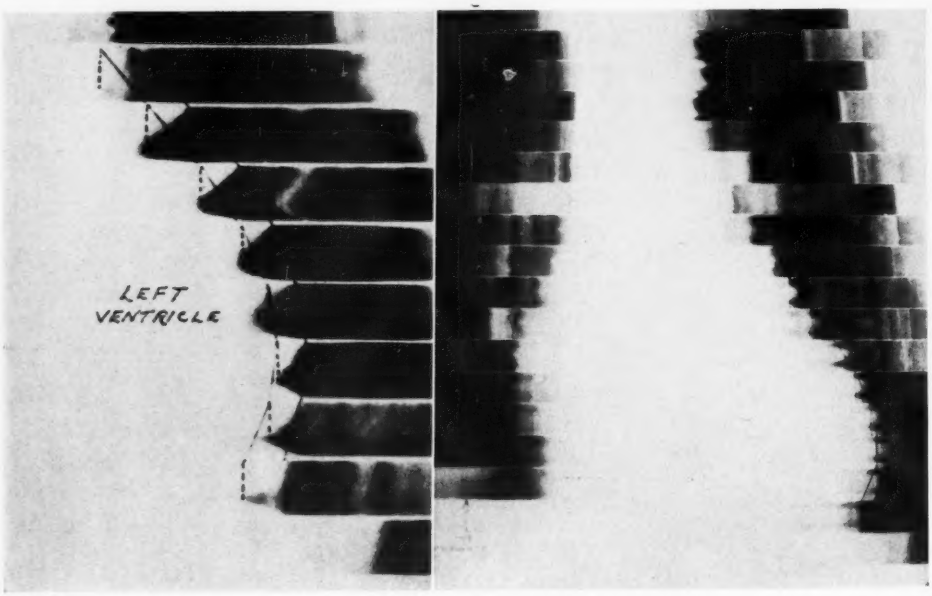
Fig. 3. Fig. 4.

Fig. 3. Teleokymogram of normal subject. Transverse diameter: systole, 11.75 cm.; diastole, 12.1 cm.
Fig. 4. Kymogram of same subject as is shown in Figure 3, taken at 30-in. distance. Transverse diameter: systole, 12.45 cm.; diastole, 13.15 cm.

volume and of stroke volume. X-ray estimates of heart-volume changes from systole and diastole exposures have been employed by Eyster and Meek (11), based on Bardeen's formula (12). Bruns and Roemer (13) and Grandi (14) also determined cardiac output by the x-ray method. This method has not attained further use because of the difficulty in procuring exposures at selected points in the cardiac cycle. Hirsch and Schwarzschild (15) have recently developed a method for taking duplicate exposures on the same film—one in diastole the other in systole—by electrocardiographic control. An exposure in full diastole is automatically set off at the peak of the R wave, before the ventricle has begun to eject, and the exposure in systole is taken 0.2 second later by means of a time delay.

Roentgen kymography provides a simple method for obtaining the outline of the heart in systole and in diastole (Fig. 5). There are two distinct methods for which the teleokymogram may be employed to estimate cardiac output. The first is by determining heart-volume changes from the size of the heart in systole and in diastole. The second is a modification of the Broemser-Ranke physical method of determining cardiac output, which makes use of data derived from arterial sphygmograms. The kymographic wave of the descending aorta serves in place of the sphygmograms. With the latter method, the elasticity of the aorta is also incidentally determined. This is an important function which has hitherto been difficult to study.

Heart Volume in Systole and in Diastole.—Of the numerous attempts to determine heart volume by roentgenography, Bardeen's formula (12) is perhaps best known (heart volume = $0.53\ A^{3/2}$, where A = frontal area of the cardiac silhouette). The deficiency of Bardeen's formula is that it considers only the frontal plane, and attempts to describe a three-dimensional object from measurements in only two of its dimensions. Palmieri (16) was able to reconstruct a plastic model of the



A *B*

Fig. 5. *A*, Outline of ventricle in systole and in diastole. Since the movements are recorded through horizontal slits, the peaks and troughs of the waves must be brought to the same horizontal level before connecting adjacent segments to obtain the outline of the ventricle in systole and in diastole. *B*, Outline of ventricle in systole and in diastole.

heart by obtaining a series of films with the subject rotated at numerous angles. Wegelius (17) has shown that a three-dimensional projection of heart size may be obtained by taking three exposures, each at right-angles to the others. The methods proposed by Palmieri and by Wegelius, while more accurate than that of Bardeen, are not practicable clinically because of the complexity of application and analysis.

Kahlstorf (18), on the basis of careful experimental investigations, proposed a simple formula for determining heart volume which remedied the deficiency of Bardeen's formula by considering measurements in the sagittal plane as well as the area of the frontal silhouette. Rohrer (19) had earlier suggested the same formula. In experiments performed by Kahlstorf on cadavers, the values for heart volume obtained with this formula corresponded closely to the actual heart volumes. Nylin (20), after a critical study, has adopted this method in his routine studies of heart volume, and remarks, "With all its shortcomings, the Kahlstorf method will, however, constitute a greater advance for practical purposes than any other method which has hitherto been employed for the determination of the size of the heart."

The formula proposed by Kahlstorf is based on the geometric method of determining the volume of a regular body from the product of certain measurements in its axial planes (area of its parallel projection times greatest diameter in the direction of projection, multiplied by a constant which depends on the geometric form of the body).

Kahlstorf's formula is:

$$V = 0.63 \times A \times T$$

where V = heart volume
A = area of the frontal plane
T = greatest horizontal anteroposterior diameter of the heart in the lateral position.

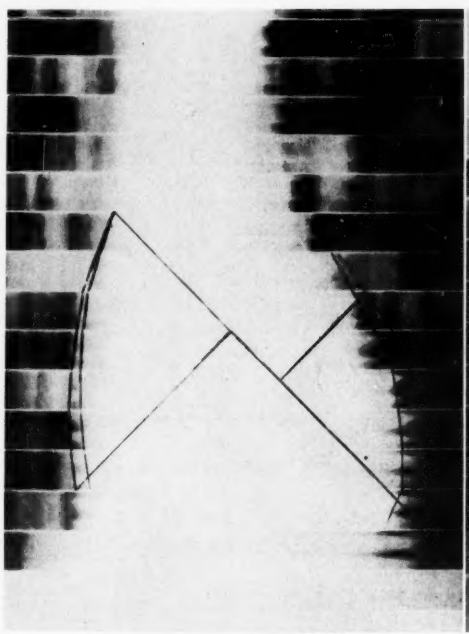


Fig. 6.

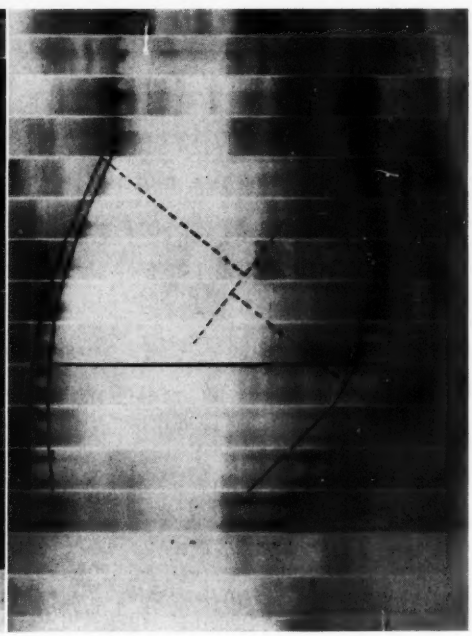


Fig. 7.

Fig. 6. Outline of heart in systole and in diastole: postero-anterior view. Long diameter: systole, 13.0 cm.; diastole, 14.23 cm. Broad diameter: systole, 9.9 cm.; diastole, 10.83 cm.

Fig. 7. Outline of heart in systole and in diastole; lateral view. Horizontal transverse diameter (Kahlstorf): systole, 9.6 cm.; diastole, 11.1 cm. (solid line). Broad diameter (Benedetti and Bollini): systole, 10.10 cm.; diastole, 11.34 cm. (broken line).

An appreciable source of inaccuracy in the planimetric determination of the area of the frontal cardiac silhouette, arises from the uncertainty of the limits of the heart on the diaphragmatic surface below and at the junction with the great vessels above. The area may be accurately determined by the product of the long and broad diameters multiplied by $\pi/4$, the heart being considered as an ellipse ($L \times B \times 0.785$) (21). Roesler (22-*a*) found a very high correlation coefficient for this formula with actual areas, and stated that it is, therefore, justifiable to use this product for the determination of the area of the cardiac silhouette in place of the less certain measurements of planimetry.

Introducing these figures into Kahlstorf's formula in place of A:

$$V = 0.63 \times (0.785 \times L \times B) \times T$$
$$= 0.5 \times L \times B \times T$$

where B = broad diameter of postero-anterior film
L = long diameter of postero-anterior film.

If two teleokymograms are taken, one in the postero-anterior and one in the lateral view (Figs. 6 and 7), the diameters required may be obtained for the heart both in systole and in diastole; and the heart volumes in systole and in diastole may be calculated. The difference between the two gives the total systolic output.

$$V = 0.5 \times L \times B \times T$$

Postero-anterior View (Fig. 6)	Diastole	Systole
L (long diameter)	14.23 cm.	13.0 cm.
B (broad diameter)	10.83 cm.	9.9 cm.
Lateral View (Fig. 7)		
T (anteroposterior horizontal diameter)	11.1 cm.	9.6 cm.

V (diastole) $= 0.5 \times 14.23 \times 10.83 \times 11.1$
$= 0.5 \times 1710.5$
$= 855.3$ c.c. (volume of heart in diastole)

V (systole) $= 0.5 \times 13.0 \times 9.9 \times 9.6$
$= 0.5 \times 1235.5$
$= 617.8$ c.c. (volume of heart in systole)

V (diastole) $-$ V (systole) = systolic output from both ventricles

$855.3 - 617.8 = 237.5$ c.c.

Stroke volume from each ventricle $= \frac{237.5}{2} = 118.8$ c.c.[2]

$$\frac{\text{Heart volume}}{\text{Stroke volume}} = \frac{855.3}{118.8} = 7.2.$$

Benedetti (23) has proposed a similar formula which corresponds with actual heart volumes even more accurately than Kahlstorf's formula.

$$V = 0.45 \times L \times B \times T_{br}$$

V = heart volume
L = long diameter in postero-anterior view
B = broad diameter in postero-anterior view
T_{br} = broad diameter in lateral view (Fig. 7).

The advantage of this formula over Kahlstorf's is that the broad diameter in the lateral view is independent of the angle of inclination of the heart; whereas the horizontal diameter (T) in Kahlstorf's formula varies somewhat with the angle of inclination of the heart (height of the diaphragm, etc.).

$$V = 0.45 \times L \times B \times T_{br}$$

Postero-anterior View (Fig. 6)	Diastole	Systole
L (long diameter)	14.23 cm.	13.0 cm.
B (broad diameter)	10.83 cm.	9.9 cm.
Lateral View (Fig. 7)		
T_{br} (broad diameter anteroposteriorly)	11.34 cm.	10.10 cm.

V (diastole) $= 0.45 \times 14.23 \times 10.83 \times 11.34$
$= 0.45 \times 1747.5$
$= 786.4$ c.c. (volume of heart in diastole)

V (systole) $= 0.45 \times 13.0 \times 9.9 \times 10.10$
$= 0.45 \times 1300.0$
$= 585.0$ c.c. (volume of heart in systole)

V (diastole) $-$ V (systole) = systolic output from both ventricles

$786.4 - 585.0 = 201.4$ c.c.

Stroke volume from each ventricle $= \frac{201.4}{2} = 100.7$ c.c.

$$\frac{\text{Heart volume}}{\text{Stroke volume}} = \frac{786.4}{100.7} = 7.8.$$

[2] The kymograms were not taken under basal conditions and the subjects were not trained for the procedure. This explains the relatively high values obtained for stroke volume.

Modification of Broemser-Ranke Method.—Broemser and Ranke (24) developed a physical method for measuring cardiac output from measurements on the arterial pulse, which has been widely employed abroad. The validity of the formula has been confirmed in animals by simultaneous determinations of output with the direct Fick method (Boger, 25), and in man by checking with values obtained with the gasometric method (Wezler and Boger, 26, Hartl, 27, Anthony and Koch, 28). A criticism raised by Bazett (29) has been answered by Broemser (30). In critical reviews, Lauber (31) and also Hartl and Bonsmann (32), accepted the Broemser method as accurate and applied it to the determination of cardiac output in various conditions.

Derivation

V = total systolic output.

The systolic output goes into—

V_1, *i.e.*, distention of the aorta and large arteries (outflow into capillary bed in diastole)

V_2, *i.e.*, systolic outflow into capillary bed.

$V = V_1 + V_2$.

V_1 = change in cross-section of aorta (ΔQ) × length over which this change is propagated (*i.e.*, length of pulse wave).

Length of pulse wave = pulse wave velocity (C) × duration of systole (S).

$V_1 = \Delta Q \times S \times C$.

A constant rate of flow into the capillary bed throughout systole and diastole is assumed, so that V_2 (outflow into capillary bed in systole) is proportional to V_1 (outflow into capillary bed in diastole) directly as the ratio, $\frac{\text{duration of systole } (S)}{\text{duration of diastole } (D)}$.

$$V_2 = V_1 \times \frac{S}{D}$$

since $V_1 = \Delta Q \times S \times C$

$$V_2 = \Delta Q \times S \times C \times \frac{S}{D}$$

$$V = V_1 + V_2 = \Delta Q \times S \times C \times \left(1 + \frac{S}{D}\right)$$

$$= \Delta Q \times S \times C \times \frac{D + S}{D}$$

D (duration of diastole) + S (duration of systole) = T (duration of cardiac cycle)

$$\therefore V = \Delta Q \times S \times C \times \frac{T}{D}$$

C (velocity of pulse wave), and S, D, and T (duration of systole, diastole, and cardiac cycle) are determined directly from simultaneous carotid and femoral sphygmograms.

ΔQ (change in cross-section of aorta) is determined by application of Frank's formula relating pulse pressure, change in arterial cross-section and pulse wave velocity.

$$\Delta Q = \frac{Q\,\Delta p}{\zeta C^2}$$

where Q = initial cross-section of aorta
Δp = pulse pressure
C = pulse wave velocity
ζ = 1.06 (specific gravity of blood).

Q (initial cross-section of aorta) is determined indirectly by assuming values from Suter's anatomical data (33).

$$V = \Delta Q \times S \times C \times \frac{T}{D}$$

$$= \frac{Q\,\Delta p}{\zeta C^2} \times S \times C \times \frac{T}{D}$$

$$= \frac{Q\,\Delta p}{\zeta C} \times S \times \frac{T}{D}$$

final formu'a $V = \frac{Q\,\Delta p\,ST}{\zeta CD} \times Z$ (Z is a constant = 0.48).

Broemser, on the basis of experiments in animals, originally gave a value of 0.6 for Z, a constant which depends on the length of the pulse wave. Further experience in man has led Broemser (30) to recommend a value of 0.5 instead. Several investigators who have checked the Broemser equation with Grollman's acetylene method have all independently found the most precise value for Z to be 0.48 (26, 27, 28).

All the factors required for the Broemser equation may be determined from the teleokymogram. Converse to Broemser's method, the change in aortic cross-section (ΔQ) is determined directly with the kymogram, and the velocity of the pulse wave is determined indirectly

$$V = \Delta Q \times C \times S \times \frac{T}{D} \times 0.48$$

ΔQ = systolic cross-section of descending aorta − diastolic cross-section
= $\pi(Dr + Aa)^2 - \pi Dr^2$

Dr = diastolic radius of descending aorta (cm.). Aa = amplitude of descending aortic wave (cm.).

$$C \text{ (velocity of pulse wave in cm./sec.)} = \frac{357}{\sqrt{\%\text{ increase in volume per mm. Hg increase in pressure}}}$$

(Bramwell's formula, 34)

$$= \frac{357}{\sqrt{\frac{\Delta Q}{\pi\, Dr^2} \times \frac{100}{\text{pulse pressure}}}}$$

Substituting these values for ΔQ and C in the above equation for V

$$V = \pi(Dr + Aa)^2 - \pi Dr^2 \times \frac{357}{\sqrt{\frac{\Delta Q}{\pi Dr^2} \times \frac{100}{\text{pulse pressure}}}} \times S \times \frac{T}{D} \times 0.48.$$

To obtain the blood flow through the ascending aorta (the total systolic output), the equation must be multiplied by this factor, 1.30.

$$V = \pi(Dr + Aa)^2 - \pi\, Dr^2 \times \frac{357}{\sqrt{\frac{\Delta Q}{\pi\, Dr^2} \times \frac{100}{\text{pulse pressure}}}} \times S \times \frac{T}{D} \times 0.48 \times 1.30.$$

Multiplying the numericals together the final equation becomes:

$$V \text{ (systolic output)} = \pi(Dr + Aa)^2 - \pi Dr^2 \times \frac{222}{\sqrt{\frac{\Delta Q}{\pi\, Dr^2} \times \frac{100}{\text{pulse pressure}}}} \times S \times \frac{T}{D}$$

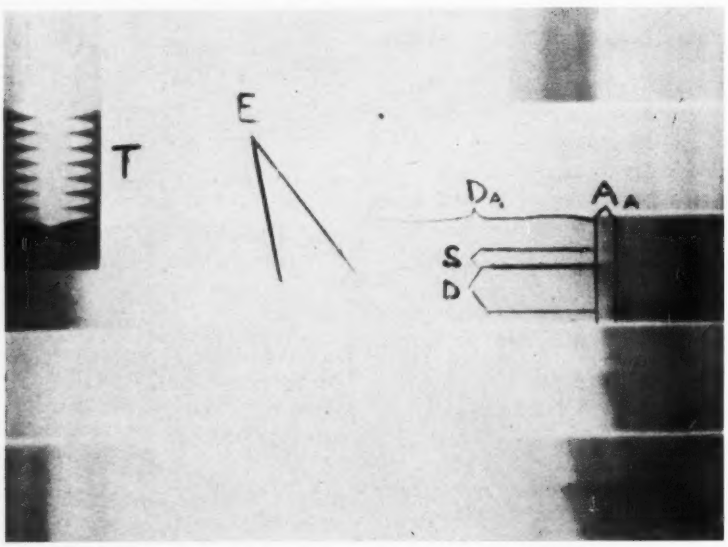


Fig. 8. Descending aorta (measurements for Broemser-Ranke equation): E = Esophagus outlined with barium; D_A = (diam. of aorta) = 2.43 cm.; A_A = (ampl. of descending aortic wave) = 0.21 cm.; S = (duration of systole) = 0.21 sec.; D = (duration of diastole) = 0.61 sec.; T = Time marker (each cycle represents 0.2 second).

This formula gives the blood flow through the descending aorta, where the measurements are made. The cross-section of the descending aorta bears a constant ratio to the cross-section of the ascending aorta, which is practically the same regardless of age or sex, according to Kani's extensive anatomical investigations (35).

$$\frac{\text{Cross-section of ascending aorta}}{\text{Cross-section of descending aorta}} = 1.30.$$

Dr = diastolic radius of descending aorta
Aa = amplitude of descending aortic wave
ΔQ = change in cross-section of descending aorta with systole = $\pi(Dr + Aa)^2 - \pi\, Dr^2$
S = duration of systole
T = duration of cardiac cycle
D = duration of diastole
pulse pressure = determined with sphygmomanometer.

Dr, the radius of the uppermost part

of the descending aorta, is determined directly with the kymogram, at the same point at which the aortic wave is measured by the Kreuzfuchs method (36). The esophagus lies directly against the right border of the aorta where it begins to descend. By filling the esophagus with a contrast medium, the right border of the descending aorta is outlined and the diameter thereby obtained; 0.2 cm. is deducted from the value, which represents the thickness of the esophageal wall.

Zdansky (37) has confirmed the Kreuzfuchs method as the most exact measure of aortic diameter. Roesler (22-*b*), too, accepts the Kreuzfuchs diameter as the only one of the numerous methods which have been proposed to measure the aorta which is anatomically exact.

Aa, the amplitude of the kymographic wave gives a true record of volume change only when the movement is entirely expansile, free of rotatory and displacement components, and when the direction of movement is parallel to the slit. These conditions are not fulfilled in the case of the ventricular and ascending aortic waves, but are satisfied for the descending aortic wave.

S, T, and D, the duration of ejection (*S*) can be determined from kymographic aortic wave within 10 per cent, by measuring the time from the beginning of systolic outthrust to the incisura. The duration of the cardiac cycle (*T*) and of diastole (*D*) are similarly determined.

Pulse Pressure.—The auscultatory determination of pulse pressure (systolic – diastolic B. P.) is accurate, with an error within 10 per cent. Bazett, LaPlace, and Scott (38) found, "The auscultatory criterion for systolic pressure checked well with that of the first recorded peripheral pulse . . . . The estimation of diastolic pressure from the fading sounds was in fair agreement with estimates from the oscillometer curve; in fact, the mean estimates by the two methods were almost identical."

Measurements obtained from the descending aortic wave of the kymogram illustrated in Figure 8 provide the necessary data for calculation of the systolic ejection by the Broemser method.

$$V = \pi(Dr + Aa)^2 - \pi Dr^2 \times \frac{222}{\sqrt{\frac{\Delta Q}{\pi Dr^2} \times \frac{100}{\text{pulse pressure}}}} \times S \times \frac{T}{D}$$

Dd	(Kreuzfuchs diameter)	= 2.43 cm.
Dr	(radius of aorta in diastole)	= 1.22 cm.
Aa	(amplitude of aortic wave)	= 0.21 cm.
B. P.	(by auscultation)	= 118/78
Pulse pressure		= 40
S	(duration of systole)	= 0.21 sec.
D	(duration of diastole)	= 0.61 sec.
T	(duration of cardiac cycle)	= 0.82 sec.

$$\Delta Q = \pi(1.22 + 0.21)^2 - \pi(1.22)^2$$
$$= \pi 2.04 - \pi 1.49$$
$$= 6.40 - 4.68$$
$$= 1.72 \text{ cm.}^2$$

$$V = 1.72 \times \frac{222}{\sqrt{\frac{1.72}{4.68} \times \frac{100}{40}}} \times \left(0.21 \times \frac{0.61}{0.82}\right)$$
$$= 1.72 \times \frac{222}{\sqrt{0.92}} \times 0.28$$
$$= 1.72 \times \frac{222}{0.96} \times 0.28$$
$$= 1.72 \times 230 \times 0.28$$
$$= 110.8 \text{ c.c. (stroke volume).}$$

Determination of Aortic Elasticity.—The velocity of the pulse wave is an expression of arterial elasticity, the velocity increasing with decreased elasticity. The determination of *C* (pulse wave velocity), by application of Bramwell's formula (34), in the equation for cardiac output, thus incidentally gives an expression of the elasticity of the aorta.

$$C = \frac{357}{\sqrt{\frac{\Delta Q}{\pi\, Dr^2} \times \frac{100}{\text{pulse pressure}}}}$$

Values obtained in several normal young adult subjects are of a magnitude of 3 to 4 meters/second, which is lower than the pulse wave velocity of more peripheral vessels. This is a logical finding, since histologically the larger arteries are relatively more elastic than the smaller ones (34). Bazett and Dreyer (39) and Fulton and McSwiney (40), in accordance with this observation, proved that the velocity in the smaller arteries is very much higher than in the larger vessels.

Data from the kymogram of Figure 8, employed in the calculation of cardiac output in the equation above, also allows determination of the pulse wave velocity in the descending aorta.

$$C = \frac{357}{\sqrt{\frac{1.72}{4.68} \times \frac{100}{40}}}$$

$$= \frac{357}{\sqrt{0.92}}$$

$$= \frac{357}{0.96}$$

= 3.73 meters per second (velocity of pulse wave).

SUMMARY

While roentgen kymography has yielded much information of clinical and physiological interest, quantitative interpretation of the kymographic waves has not been possible because of the short focal distance at which kymograms have hitherto been made.

Teleoroentgenographic distance in kymography has been attained in the present study by the use of a tube of large capacity energized by a three phase generator, which tends to maintain a high even output. For an exposure of 1.5 seconds, 125 ma. at from 60 to 85 kv. are employed. The photographic quality of the films obtained with this technic is excellent. Some 350 teleokymograms have been taken thus far.

The accurate representation of the cardiac image suggests the possible application to the problems of heart size and output. There are two distinct methods for which the teleokymogram may be employed to estimate cardiac output. The first is by determining heart-volume changes from the size of the heart in systole and in diastole. The second is a modification of the Broemser-Ranke physical method of determining cardiac output, which makes use of data derived from arterial sphygmograms. The kymographic wave of the descending aorta serves in place of the sphygmograms.

What final value these methods may have, remains to be determined by comparisons with actual cardiac outputs determined by one of the accepted methods. The volumetric method is subject to the same criticism that has been raised against similar attempts, but it is simple in application, requiring only a postero-anterior and a lateral view. It has the further advantage of giving not only the stroke volume but the heart volume as well. The ratio, $\frac{\text{heart vol.}}{\text{stroke vol.}}$ is of greater significance as an expression of the functional condition of the heart than is the stroke volume alone.

The modification of the physical method of Broemser appears to have definite advantages over the method as it is applied. It is very simple, requiring only a postero-anterior exposure with barium in the esophagus, and a determination of blood pressure by the usual means. It has the further advantage of eliminating the greatest source of inaccuracy in the Broemser formula. The cross-section of the aorta is determined directly, instead of assuming values from anatomical data as the equation requires.

The velocity of the pulse wave in the aorta, which is determined incidentally for the Broemser equation, is an expression of arterial elasticity, the velocity increasing with decreased elasticity. The teleoroentgen kymogram may thus find a further application in the estimation of elasticity of the aorta.

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CASE REPORT

DEMONSTRATION OF A BALL-VALVE OBSTRUCTION OF THE COMMON DUCT

By JOSEPH T. DANZER, M.D.
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From the Franklin Hospital

Ball-valve obstructions and their mechanisms have been describe dmany times in the literature. They have been known to occur in the common duct, in which instance a stone, according to its position, may be the cause of intermittent, partial, or complete obstruction.

The demonstration of stones in the common duct by means of opaque medium is now a relatively common occurrence, but the demonstration of a ball-valve obstruction in the common bile duct is unusual.

Mrs. E. M., white, aged 68 years, entered the Franklin Hospital on May 21, 1938, complaining of severe pain in the right upper quadrant. She stated that during the previous two weeks she had had frequent attacks of pain in that area. Cholecystograms were done on May 24; the gall bladder could not be visualized and no evidence of stones could be seen.

The past history was of no significance, except that a stone had been removed from her right kidney ten years previously.

The patient was operated upon on May 28, 1938. The surgeon's report of the operative findings stated that the gall bladder was markedly distended with bile-stained fluid; no stones were found. The biliary ducts were thickened and no stones were palpable. About one-third of the gall bladder was removed, the remaining portion being stitched together and, because the patient's condition did not warrant further operative procedure, a mushroom catheter was placed in the gall bladder and the wound closed.

Fig. 1.

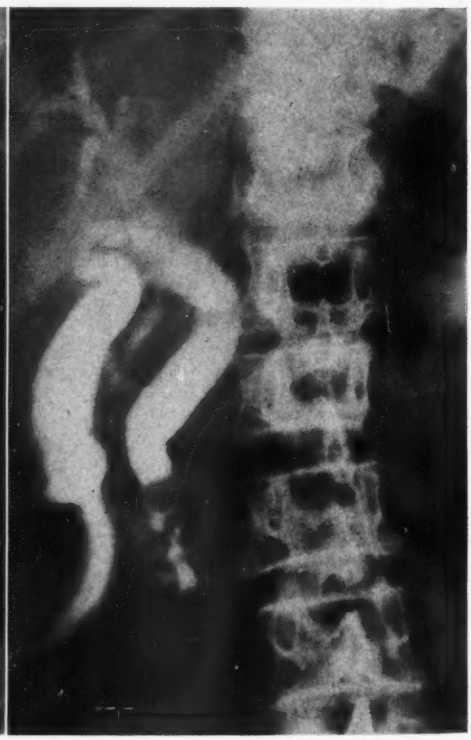

Fig. 2.

Fig. 1. First film taken, showing the gall bladder and common duct well filled. There is a fairly large non-opaque stone in about the center of the common bile duct.

Fig. 2. Second film taken, showing that the stone has now moved down to the lower end of the common bile duct, completely blocking the passage of lipiodol.

The patient did poorly; she continued to vomit and had repeated attacks of severe pain in the right upper quadrant. On June 21, she was taken to the X-ray Department and a small amount of lipiodol was introduced into the drainage tube under fluoroscopic control. A film was taken which showed the gall bladder and common duct to be well filled with opaque medium, the common duct to be dilated, and at about its center, a large non-opaque stone to be visible. As there was no lipiodol in the duodenum, more was injected until the patient complained of severe pain. A second film was taken which showed the stone to have moved to the lower end of the duct, completely blocking the flow of the lipiodol.

The patient was again operated upon on June 24, and the stone was removed. She was unable to withstand the shock of the second surgical interference and died the following day.

We wish to thank Dr. G. C. McCandless for his aid in performing the technical portion of this examination.

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THE BUSINESS SIDE OF RADIOLOGICAL PRACTICE

A Bulletin for Fellows and Residents in Radiology in Their Final Year of Post-graduate Training

In his preface to that valuable little book by Theodore Wiprud, "The Business Side of Medical Practice" (1), Morris Fishbein says: "The practice of medicine involves not only the diagnosis, treatment, and prevention of disease, but also the simultaneous maintenance of a place in which these activities are carried on—known as an office—a system for recording those to whom the methods are applied, together with the assessment of charges for the services rendered, a technic for keeping abreast of progress in the medical field, and participation in innumerable medical, public, and other activities which have come to be an integral portion of the physician's life."

Too often the new practitioner who has finished his medical training is apt to minimize the importance of the extra-scientific problems which arise when he begins the practical application of his professional knowledge. In relatively few schools of medicine does the student have the advantage of even a brief course of instruction in the business, sociological, or legal aspects of medical practice. It is wise, therefore, for the neophyte to give serious thought to business details and socio-economic principles before beginning practice. A good start not infrequently determines the ultimate professional success of the individual.

Because the socio-economic problems currently confronting the profession of medicine are especially palpable in the case of radiology, the graduate student in this specialty should take time to familiarize himself with the source and nature of some of these problems and the recommended procedures for coping with them. The book by Wiprud, mentioned above, provides a useful introduction to an understanding of the business aspects of medical practice and presents an elementary discussion of all the extra-scientific problems with which the new practitioner will be confronted. Office procedures, accounting systems, and collection methods are briefly discussed. It is such items as these with which the inexperienced doctor is apt to have difficulty. Every doctor must be a bit of a business man, and, rarely having received academic training in these subjects, he should seek assistance in sound business details. A proper accounting system, adequate files and records, and efficient clerical methods are essential to the conduct of a successful practice.

Legal questions pertaining to radiology, with a valuable discussion of the specialist's rights and duties in court and out, are admirably set forth in a book by Samuel W. Donaldson, M.D. (2), himself a practising radiologist. It should be in the library of every radiologist when he begins his practice. A useful bibliography is included. While Donaldson's book, and others similar, contains information of interest to the radiologist, no physician should commit the error of "self-diagnosis" or "home treatment." Sufficient malpractice insurance and a good lawyer provide the only safe solutions to questions of medical jurisprudence. Modern doctrines in the law, especially in regard to alleged negligence in radiology, make it imperative that the radiologist provide himself with these protections.

Socio-economic Problems.—The new practitioner of radiology enters his profession in a day when a rapidly changing social era renders obsolete much of the thinking of his professional predecessors. It is vitally important that he acquire a thorough understanding of the nature of these modern developments and their implications for medicine.

Much valuable material may be secured from the Bureau of Medical Economics of the American Medical Association (535 No. Dearborn St., Chicago).[1] Every physician should avail

[1] An Introduction to Medical Economics, revised (112 pages).
Economics and the Ethics of Medicine (72 pages).
New Forms of Medical Practice (64 pages).
Contract Practice (24 pages).
Some Phases of Contract Practice (32 pages).
Group Practice (48 pages).
Medical Service Plans (36 pages).
Organization of Medical Services (56 pages).
Medical Relations Under Workmen's Compensation, revised (180 pages).
Care of the Indigent Sick (128 pages).
Sickness Insurance Catechism (16 pages).
Sickness Insurance and Sickness Costs (20 pages).

himself of the efforts on his behalf carried on by the parent medical body. In addition to the comprehensive studies obtainable from the American Medical Association, the practising radiologist may always look to the Inter-Society Committee for Radiology and the American College of Radiology for service and assistance. Practical solutions and valuable discussion of many of the financial problems which arise in the conduct of his practice may be found in various bulletins available at the headquarters office. Specific questions directed to either of these two organizations will receive the prompt attention of standing committees and a full-time staff.

There are scores of books available on the socio-economic phases of medicine, some attacking the present system of practice and some defending it. Particularly good among the latter is "Economic Problems of Medicine," by Arthur C. Christie, M.D. (3), who, incidentally, is also a practising radiologist. Its bibliography will direct the reader to more extensive studies on various aspects of the broad and complex problems which complicate the present-day practice of private medicine.

Growth of Hospitals.—The science of radiology grew to maturity during a period when fundamental changes were taking place in American social economy. It achieved its position as an important and indispensable specialty of medicine at a time when the entire profession was beginning to feel the effect of these modern trends. It is not strange, therefore, that the specialty of radiology should be affected by certain unwholesome conditions which owe their origin to two definite factors: the era during which the specialty was developed, and the mechanical features involved in the practical application of the science.

During the years when radiology was being advanced from a physical technic to a clinical specialty, the hospital acquired a position of new importance in the delivery of medical service. The functions of the hospital were extended in such a manner that doctors began to spend more and more of their time in the hospital. There are to-day over 6,000 registered hospitals in this country with a bed capacity of more than a million and a half, and new construction is going on at the rate of 100 hospital beds per day. Much of the service formerly rendered to the patient in his home is now rendered in the hospital. During this development, it was natural that radiology should come to be extensively practised in the hospital. At the same time certain problems arose in connection with delivery of the specialist's services in the hospital.

This increase in hospitalization, plus the fact that the practice of radiology requires an initial investment of several thousand dollars for necessary equipment, is responsible for most of the peculiar problems that demand the organized attention of radiologists. Radiology is not only faced with the critical situations confronting all medicine but it has fallen heir to many difficulties of its own. Endowed with an earnest desire to protect the specialty against harmful influences which would obstruct the continued growth and progress of its science, organized radiologists have within recent years taken certain steps and enunciated certain principles which will lead the way toward solving some of the vexing problems affecting the practice of radiology in hospitals.

The practice of radiology is the practice of medicine, whether that practice is conducted in a hospital building or a medical office building.[2] Just as each and every step in the

Sickness Insurance Not the Remedy (16 pages).

Some Defects in Insurance Propaganda (21 pages).

Health Insurance in England and Medical Society Plans in the United States (20 pages).

A Critical Analysis of Sickness Insurance (96 pages).

Handbook of Sickness Insurance, State Medicine and the Cost of Medical Care (192 pages).

The Radio Debate on State Medicine (28 pages).

Group Hospitalization: A Report of Experiences (296 pages).

Factual Data on Medical Economics (67 pages).

Organized Payments for Medical Services (185 pages).

[2] Official Proceedings of the House of Delegates, American Medical Association, p. 33, 1934.

WHEREAS, It has been reported to the officers and members of the Section on Radiology of the American Medical Association that an intolerable condition exists between certain otherwise acceptable hospitals and their departments of radiology; and

WHEREAS, It is known that in several such hospitals the business management does the collective bargaining for x-ray business with staff members and outsiders to the detriment and professional and financial loss of their staff roentgenologists; and

WHEREAS, Such practice is not only unethical but places such hospitals on a direct competitive medical practice basis with their respective roentgenologists, which practice has been declared illegal in several states; and

WHEREAS, the practice of roentgenology or radiology is *ipso facto* the practice of medicine and cannot be separated therefrom; therefore be it

RESOLVED, That the House of Delegates of the American Medical Association go on record as opposing

practice of surgery, whether it be the taking of a history, the insertion of a scalpel, or the recording of observations, constitutes the practice of surgery, so does every step, technical or interpretative, constitute the practice of radiology. The interjection of a third party into the practice of radiology interferes with the proper practice of that specialty just as it does in surgery. Radiology is a clinical specialty which frequently requires a close personal relationship between doctor and patient to insure thoroughness in examination and diagnosis. The quality of radiology is threatened when any third party assumes a dominant rôle in the delivery of radiological service to the patient. Much of radiology must be practised in the hospital, but the hospital corporation should in no way alter the relationship between the doctor and his patient.

MAC F. CAHAL
Executive Secretary

(To be concluded next month)

the exploitation of members of their own body in the manner outlined; and be it further

RESOLVED, That the House of Delegates of the American Medical Association in session duly assembled orders this resolution to be referred to the Council on Medical Education and Hospitals for the study and formulation of plans tending to the abatement of these highly unprofessional and obnoxious evils.

Official Proceedings of the House of Delegates, American Medical Association, p. 42, 1936.

(1) It reiterates the principle enunciated by the House of Delegates, at Cleveland, in 1934, "That the practice of radiology, whether for diagnostic or therapeutic purposes, constitutes in fact the practice of medicine." The action of the House of Delegates, in 1925, establishing a section on radiology confirms this principle.

(2) It further recommends that all services connected with the practice of radiology be under the direct control and supervision of the medical profession, and this same principle pertains to other technical and professional services.

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RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles; *Secretary,* Carl D. Benninghoven, M.D., 95 S. El Camino Real, San Mateo.

Los Angeles County Medical Association, Radiological Section.—President, E. N. Liljedahl, M.D., 1322 North Vermont Ave., Los Angeles; *Vice-president,* M. L. Pindell, M.D., 678 South Ferris Ave.; *Secretary,* Wilbur Bailey, M.D., 2007 Wilshire Blvd.; *Treasurer,* Henry Snure, M.D., 1414 South Hope Street. Meets every second Wednesday of each month at County Society Building.

Pacific Roentgen Club.—Chairman, Karl M. Bonoff, M.D., Los Angeles; *Members of Executive Committee,* I. S. Ingber, M.D., A. C. Siefert, M.D., D. R. MacColl, M.D.; *Secretary-Treasurer,* L. Henry Garland, M.D., 450 Sutter St., San Francisco. Executive Committee meets quarterly; Club meets annually during annual session of the California Medical Association.

San Francisco Radiological Society.—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club.—President, F. B. Stephenson, M.D., 452 Metropolitan Bldg.; *Vice-president,* K. D. A. Allen, M.D., 452 Metropolitan Bldg.; *Secretary,* E. A. Schmidt, M.D., 4200 E. Ninth Ave.; *Treasurer,* H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Samuel M. Atkins, M.D., 63 Central Ave., Waterbury; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida Radiological Society.—President, H. B. McEuen, M.D., Jacksonville; *Vice-president,* Joseph H. Lucinian, M.D., Miami; *Secretary-Treasurer,* John N. Moore, M.D., 210 Professional Bldg., Ocala. Meetings held in November and at the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—President, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president,* L. P. Holmes, M.D., University Hospital, Augusta; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, Roe J. Maier, M.D.; *Vice-president,* Adolph Hartung, M.D.; *Secretary,* Chester J. Challenger, M.D., 3117 Logan Blvd. Meetings the second Thursday of each month from October to May, except December, at the Hotel Sherman.

Illinois Radiological Society.—President, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president,* Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer,* Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—The next meeting will be in Peoria, in May, 1940. The officers are: *Chairman,* Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago; *Secretary,* Harry W. Ackemann, M.D., 321 W. State St., Rockford.

INDIANA

The Indiana Roentgen Society.—President, Juan Rodriguez, M.D., 2902 Fairfield Ave., Fort Wayne; *President-elect,* H. H. Inlow, M.D., Shelbyville; *Vice-president,* Wemple Dodds, M.D., Crawfordsville; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—President, D. B. Harding, M.D., Lexington; *Vice-president,* I. T. Fugate, M.D., Louisville; *Secretary-Treasurer,* Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Chairman, Whitmer B. Firor, M.D., 1100 N. Charles St.; *Secretary,* Walter L. Kilby, M.D., 101 W. Read St. Meetings third Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, Sam W. Donaldson, M.D., 326 N. Ingalls St., Ann Arbor:

Vice-president, Clarence Hufford, M.D., 421 Michigan Ave., Toledo, Ohio; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave.

Michigan Association of Roentgenologists.—President, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit; *Vice-president*, M. R. Cooley, M.D., Mercy Hospital, Jackson; *Secretary-Treasurer*, C. S. Davenport, M.D., 609 Carey St., Lansing. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—President, Leo G. Rigler, M.D., University Hospital, Minneapolis; *Vice-president*, Harry M. Weber, M.D., Mayo Clinic, Rochester; *Secretary*, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. These officers will assume their duties after the Summer meeting which will be held in connection with the Minnesota State Medical Society, May 31 to June 2, 1939.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Kansas; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Paul C. Schnoebelen, M.D.; *Secretary*, W. K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—President, T. T. Harris, M.D., Clarkson Memorial Hospital, Omaha; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Langdon T. Thaxter, M.D., Maine General Hospital, Portland, Maine; *Secretary*, Aubrey O. Hampton, M.D., Massachusetts General Hospital, Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, P. S. Avery, M.D., Middlesex Hospital, New Brunswick; *Vice-president*, J. G. Boyes, M.D., 912 Prospect Ave., Plainfield; *Treasurer*, H. A. Vogel, M.D., 1060 E. Jersey St., Elizabeth; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Counsellor*, A. W. Pigott, M.D., Skillman. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—President, Henry A. Barrett, M.D., 140 East 54th St., New York City; *President-elect*, I. J. Landsman, M.D., 910 Grand Concourse, New York City; *Vice-president*, Frederic E. Elliott, M.D., 122 76th St., Brooklyn; *Treasurer*, Solomon Fineman, M.D., 133 East 58th St., New York City; *Secretary*, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—President, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.; *Secretary-Treasurer*, L. J. Taormina, M.D., 1093 Gates Ave. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, Chester D. Moses, M.D., 333 Linwood Ave.; *Vice-president*, Edward C. Koenig, M.D., 100 High St.; *Secretary-Treasurer*, Joseph S. Gian-Franceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—President, Jesse Randolph Pawling, M.D., 305 Clinton St., Watertown; *Vice-president*, Albert Lenz, M.D., 613 State St., Schenectady; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—President, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Harry M. Imboden, M.D., 30 W. 59th St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains, N. Y.; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast

Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, J. H. West, M.D., 10515 Carnegie Ave.; *Vice-president*, Harry Hauser, M.D., City Hospital; *Secretary-Treasurer*, H. A. Mahrer, M.D., 10515 Carnegie Ave. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President*, B. M. Warne, M.D., Doctors Building, Cincinnati; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Louis A. Milkman, M.D., Medical Arts Bldg., Scranton; *First Vice-president*, James E. Ginter, M.D., Dubois; *Second Vice-president*, Alexander Stewart, M.D., Shippensburg; *Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect*, Harvey N. Mawhinney, M.D., 6546 Darlington Road, Pittsburgh; *Editor*, William E. Reiley, M.D., Clearfield; *Assistant Editor*, Sydney J. Hawley, M.D., Danville.

The Philadelphia Roentgen Ray Society.—President, H. Tuttle Stull, M.D., 3260 N. Broad St., Philadelphia, Penna.; *Vice-president*, Joseph E. Roberts, Jr., M.D., 403 Cooper St., Camden, N. J.; *Secretary*, Barton R. Young, M.D., Temple University Hospital, Philadelphia, Penna.; *Treasurer*, Fay K. Alexander, M.D., Chestnut Hill Hospital, Philadelphia, Penna.

The Pittsburgh Roentgen Society.—President, Zoe A. Johnston, M.D., 601 Jenkins Arcade; *Vice-president*, Prentiss A. Brown, M.D., and *Secretary-Treasurer*, Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, Percy D. Hay, Jr., M.D., McLeod Infirmary, Florence; *Secretary-Treasurer*, Hillyer Rudisill, Jr., M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—President, Steve W. Coley, M.D., Methodist Hospital, Memphis; *Vice-president*, Eugene Abercrombie, M.D., 305 Medical Arts Bldg., Knoxville; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, Jerome H. Smith, M.D., San Antonio; *President-elect*, C. F. Crain, M.D., Corpus Christi; *First Vice-president*, M. H. Glover, M.D., Wichita Falls; *Second Vice-president*, G. D. Carlson, M.D., Dallas; *Secretary-Treasurer*, Henry C. Harrell, M.D., 517 Pine St., Texarkana. Meets annually. Temple is place of next meeting, Oct. 20 and 21, 1939.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president*, L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary*, V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary*, T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

WISCONSIN

Milwaukee Roentgen Ray Society.—President, H. W. Hefke, M.D.; *Vice-president*, Frederick C. Christensen, M.D.; *Secretary-Treasurer*, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May a one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

QUO VADIS, AMERICAN X-RAY TECHNICIAN?

During the last ten years I have become more and more interested in the training of x-ray technicians, in their certification, in their organization, and in their efforts to keep themselves informed regarding recent advances in x-ray technic. My first connection started with the establishment of a 12 months' training course for x-ray technicians in the University of Wisconsin Medical School, in 1930, and further experience was gained during my five years of service as a member of the American Registry of X-ray Technicians. Recently there has been considerable criticism on the part of the radiologists regarding the activities of the national organization of the technicians, named "The American Society of X-ray Technicians" and because I have had an opportunity to analyze the situation very closely and since there apparently has occurred also some misunderstanding, it seemed timely to present both sides of the question to the readers of this Journal.

There exists a close relationship between the R.S.N.A. and the A.S.X.T. The former appoints four and the latter two trustees of the American Registry of X-ray Technicians, which constitutes the national examining board for x-ray technicians. Furthermore, no technician can qualify for membership in the technicians' national organization unless he or she has been certified by the Registry Board and is in good standing. It may not be amiss to state that objections were raised to the appointment of two technicians as trustees of the Registry Board. However, if one considers the fact that it is the technicians who are regulated by the Registry and that the technicians, through examination and yearly renewal fees, are financing the Board, which has been self-supporting for many years, this seems a fair and reasonable arrangement.

An analysis of the criticism voiced shows three major "bones of contention": (1) the official journal of the society, (2) publicity in connection with conventions, and (3) papers presented at conventions.

(1) The fundamental right of the society to publish a journal can hardly be questioned. That the material presented there should be limited strictly to technical topics is understood. In order to encourage and facilitate such a policy an Advisory Publication Committee, consisting of Dr. Menville, Dr. Rigler, and the writer has recently been appointed. This is a real step toward the satisfactory solution of that particular problem.

(2) The publicity connected with any convention is often difficult to control because of the over-zealous attitude of some newspaper reporters. In certain instances undesirable press notices have been caused by over-enthusiastic individual members and in a few cases by a lack of understanding of the true situation. However, at the New York meeting as well as at the previous meeting a year ago in Madison, a very earnest effort was made to curb such undesirable publicity by close co-operation of the officers of the society with the Committee on Education and Registration, which consists of three radiologists and two registered technicians. As far as could be ascertained, no glaring headlines nor medical material appeared in the press during these two conventions.

(3) The papers delivered at the annual convention—and that includes the titles as listed in the program—have been the subject of the most severe criticism. While it must be admitted in all fairness that frequently physician contributors—not radiologists—were the greatest offenders in presenting medical material, it is also a fact that the borderline between medical and strictly technical phases of radiology is sometimes hard to draw. Realizing the importance of this problem the society decided, in 1937, to have the Committee on Education and Registration (of which the writer has been chairman for the last two years)

censor all manuscripts to be presented at the annual convention. Two radiologists, members of the R.S.N.A., and one technician, member of the A.S.X.T., constituted the board of review. In case of dissenting opinion the manuscript in question was submitted to the President of the American Registry of X-ray Technicians for final decision. Of course, there have been complaints by those whose papers were partially or wholly rejected, but these objections came almost exclusively from non-members. To the credit of the officers of the technicians' society it must be stated that they unreservedly supported all decisions of the censoring committee, even in the face of some very unpleasant reactions. The suggestion was offered also that each individual radiologist censor his technician's paper. Where this was done it soon appeared that there exists considerable difference of opinion just where the line between medical and technical radiology should be drawn, even among radiologists. It was little short of embarrassing when the censoring committee had to eliminate parts of manuscripts which had been passed by the technician's supervising radiologist. Consequently there is little doubt that a central committee censoring all manuscripts will assure a more uniform policy. In order to obtain what one may call a "cross-section of opinion" of the radiologists in this country, over a hundred letters were mailed recently to the counselors of the R.S.N.A. and the secretaries of the radiological organizations asking their advice on the various problems outlined above. It is hoped that there will be many replies, especially from those who, in the past, have objected to certain actions of the technicians' society, and that constructive criticism is offered—which will be gratefully accepted.

As an individual, the x-ray technician is the trusted and valuable assistant of the radiologist; as a group, I have found the great majority of technicians sincere in their intentions, eager to please the radiologist, seeking constantly his advice in matters pertaining to their organization, and very appreciative of a "helping hand." Their meetings in state groups and the annual national convention are held primarily to serve one major purpose, *i.e.*, to provide educational facilities and to stimulate the individual to add to his or her knowledge, which, after all, is apt to make better technicians and is of distinct advantage to the radiologist. The fact that last year the society passed a resolution expressing itself as opposed to unionism should not remain unmentioned.

If this brief outline has clarified some debated points, if it has aroused interest in this subject in others and—last, not least—created the desire for further information in some, my humble efforts are well repaid. I trust the readers of this Journal will feel free to write me as to their own reaction—pro or con—on this subject; your letters are welcome! Those of us who have been and are now acting in an advisory capacity to the A.S.X.T. are desirous of carrying out your wishes as far as possible, and I personally feel very strongly that it is better for American radiology as a whole to take an active interest in the technicians' organization, assist in its development, and—rather than stand by indifferently or oppose it—help steer their ship along sane channels.

ERNST A. POHLE, M.D.

ANNOUNCEMENTS

NEXT ANNUAL MEETING REFRESHER SERIES

Following is a description of the Refresher Series to be given during the next Annual Meeting of the Radiological Society of North America, at Atlanta, Ga., Dec. 10–15, 1939. See Announcement among the advertising pages.

Course No. 1. A REVIEW OF SOME CASES OF BONE TUMORS: J. T. Murphy, M.D., Toledo, Ohio, and Plinn F. Morse, M.D., Detroit, Michigan. Five-hour course. Sunday, 2 P.M. to 5 P.M. and 7 P.M. to 9 P.M.

This course is to be conducted on the plan of a roentgen-clinical conference. The clinical manifestations of various bone tumors will be presented and differential diagnosis discussed. Photographs and photomicrographs will be shown and discussed jointly by Dr. Murphy and Dr. Morse. Working classification for differential diagnosis of bone tumors will be submitted and criteria for their differentiation presented.

Course No. 2. DISEASES OF THE SMALL INTESTINE: Ross Golden, M.D., New York City. Two-hour course. Monday, 8:30 A.M. to 10:30 A.M.

(*A*) Method of examination

PLAN OF PRESENTATION

SUNDAY		MONDAY		TUESDAY	
2–5 P.M.	7–9 P.M.	8:30–9:30 A.M.	9:30–10:30 A.M.	8:30–9:30 A.M.	9:30–10:30 A.M.
1. Radiology of Bone Tumors J. T. Murphy, M.D., and Plinn F. Morse, M.D.		**2. Diseases of the Small Intestine** Ross Golden, M.D.		**3. Radiology of the Gastro-intestinal Cholecystography** B. R. Kirklin, M.D.	
5. Radiology of Sinuses and Mastoids G. W. Grier, M.D.	**6. Film - reading Session** W. E. Chamberlain, M.D., and L. H. Garland, M.D.	**7. The Anatomy, Physiology, and Mechanics of the Chest as the Basis for Classifications** W. Walter Wasson, M.D.			
10. The Basic Principles of Protracted Fractionated External Irradiation Milton Friedman, M.D.	**11. Film - reading Session** M. C. Sosman, M.D., and Ross Golden, M.D.	**12. X-ray Therapy in the Treatment of Carcinoma of the Skin** James M. Martin, M.D.		**13. Radiation Therapy of the Lymphoblastomas** B. P. Widmann, M.D.	
16. Roentgen Analysis of Fractures W. E. Chamberlain, M.D.		**17. Roentgen Kymography** Wendell G. Scott, M.D.	**18. Radiology of the Genito-urinary Tract** B. H. Nichols, M.D.	**17. Roentgen Kymography (continued)** Wendell G. Scott, M.D.	**18. Radiology of the Genito-urinary Tract (continued)** B. H. Nichols, M.D.
		20. Radiologic Investigation of the Spine and Sacro-iliac Joints Fred J. Hodges, M.D.		**21. Radiology of the Skull** M. C. Sosman, M.D.	
25. Physics of Radiation (Elementary course) 2–3:30 P.M. O. Glasser, Ph.D.	**25. Physics of Radiation (Elementary course)** J. L. Weatherwax, M.A.	**25. Physics of Radiation (Elementary course cont'd)** 9 to 10:30 A.M. Otto Glasser, Ph.D.		**25. Physics of Radiation (Elementary course cont'd)** 9 to 10:30 A.M. E. H. Quimby, M.A.	
					26. Physics of Radiation (Advanced): High voltage generators, cyclotron, van de Graaff, Sloan, etc. O. Glasser, Ph.D.

PLAN OF PRESENTATION

WEDNESDAY		THURSDAY		FRIDAY
8:30–9:30 A.M.	9:30–10:30 A.M.	8:30–9:30 A.M.	9:30–10:30 A.M.	8:30–9:30 A.M. 9:30–10:30 A.M.
Tract and Gall Bladder Lesions of the Esophagus and Cardiac Portion of the Stomach		Lesions of the Stomach and Duodenum		**4. Radiology of the Colon** E. L. Jenkinson, M.D.
the Study of Chest Diseases and Their		**8. Cardioradiology** Samuel Brown, M.D.		**9. Roentgen Diagnosis of Silicosis** W. M. Doughty, M.D.
14. The Treatment of Cancer of the Breast U. V. Portmann, M.D.				**15. The Treatment of Carcinoma of the Cervix** Edwin C. Ernst, M.D.
17. Roentgen Kymography (conclusion) Wendell G. Scott, M.D.	**18. Radiology of the Genito-urinary Tract (conclusion)** B. H. Nichols, M.D.	**19. The Roentgenologic Aspects of the Arthritides** L. H. Garland, M.D.		
22. Encephalography and Ventriculography Karl Kornblum, M.D.	**23. Myelography** John D. Camp, M.D.	**22. Encephalography and Ventriculography (conclusion)** Karl Kornblum, M.D.	**23. Myelography (conclusion)** John D. Camp, M.D.	**24. Bone Diseases of Children** Leo G. Rigler, M.D.
25. Physics of Radiation (Elementary course cont'd) 9 to 10:30 A.M. J. L. Weatherwax, M.A.		**25. Physics of Radiation (Elementary course cont'd)** 9 to 10:30 A.M. E. H. Quimby, M.A.		**25. Physics of Radiation (Elementary course concluded)** 9 to 10:30 A.M. J. L. Weatherwax, M.A.
	26. Physics of Radiation (Advanced): Nuclear physics (theoretical), neutrons and artificial radio-activity E. H. Quimby, M.A.		**26. Physics of Radiation (Advanced): Nuclear physics (practical), production and measurement of some of the new radiations** M. Tuve	

(*B*) Normal small intestine
(*C*) Disturbances in physiology
1. Multiple peritoneal adhesions
2. Mesenteric lymphadenitis
3. Vagotonia
4. Deficiency states
(*a*) Non-tropical sprue; adult celiac disease (chronic steatorrhea), infantile celiac disease
(*b*) Dietary deficiency
(*c*) Low serum albumen
(*d*) Acholia
5. Allergy
6. Ileus (paralytic and mechanical)
(*D*) Inflammations
1. Tuberculosis
2. Non-specific enteritis
(*E*) Neoplasms
1. Benign
2. Malignant
(*a*) Carcinoma, carcinoid
(*b*) Lymphoblastomas (localized, diffuse).

Course No. 3. RADIOLOGY OF THE GASTRO-INTESTINAL TRACT AND GALL BLADDER: B. R. Kirklin, M.D., Rochester, Minnesota. Six-hour course. Tuesday, 8:30 A.M. to 10:30 A.M.; Wednesday, 8:30 A.M. to 10:30 A.M.; Thursday, 8:30 A.M. to 10:30 A.M.

Tuesday: Cholecystography.—The technic of oral cholecystography will be discussed in detail. This will be followed by a discussion of the cholecystographic diagnosis of lesions of the gall bladder. The cholecystographic manifestations of tumors of the gall bladder will be shown.

Wednesday: Roentgen Diagnosis of Lesions of the Esophagus, and Cardiac Portion of the Stomach.—The technic of fluoroscopic and radiographic examination of the upper digestive tube will be discussed. This will be followed by a consideration of lesions of the esophagus and cardiac portion of the stomach.

Thursday: Roentgen Diagnosis of Lesions of the Stomach and Duodenum.—The roentgen diagnosis of the following conditions will be discussed: Cancer, peptic ulcer, duodenitis, gastritis, benign tumors, pyloric and prepyloric lesions, and gastric syphilis.

Course No. 4. RADIOLOGY OF THE COLON: E. L. Jenkinson, M.D., Chicago, Illinois. Two-hour course. Friday, 8:30 A.M. to 10:30 A.M.

This course will consist of a review of the anatomy and physiologic features of the colon. Diseases of the colon, as diagnosed by roentgen study, will be classified. Methods of examination will be discussed and differential diagnosis outlined.

Course No. 5. RADIOLOGY OF SINUSES AND MASTOIDS: G. W. Grier, M.D., Pittsburgh, Pennsylvania. Three-hour course. Sunday, 2 P.M. to 5 P.M.

The technic which the author has found most satisfactory, and the positions that are used routinely and in special cases will be described.

The apparatus which the author uses to make stereoscopic views of the sinuses easily will be demonstrated.

The various diseases which involve the nasal sinuses will be discussed and films shown to demonstrate these as fully as possible. Special effort will be made to correlate x-ray findings with clinical and pathologic findings.

Acute and chronic mastoiditis will be discussed, and also petrositis. The value and limitations of x-ray in mastoiditis will be stressed.

Course No. 6. FILM-READING SESSION. W. Edward Chamberlain, M.D., Philadelphia, and L. H. Garland, M.D., San Francisco, California. Two-hour course. Sunday, 7 P.M. to 9 P.M.

Those attending the course are invited to bring case reports and radiographs of interest or difficult cases for presentation and informal discussion. Those conducting the conferences will depend upon voluntary submission of material by those enrolled.

Course No. 7. THE ANATOMY, PHYSIOLOGY, AND MECHANICS OF THE CHEST AS THE BASIS FOR THE STUDY OF CHEST DISEASES AND THEIR CLASSIFICATION: W. Walter Wasson, M.D., Denver, Colorado. Six-hour course. Monday, 8:30 A.M. to 10:30 A.M.; Tuesday, 8:30 A.M. to 10:30 A.M.; Wednesday, 8:30 A.M. to 10:30 A.M.

This is an effort to portray the chest so that the clinician or radiologist can visualize the thoracic viscera and the mechanics and physiology of this viscera. A child begins

life with certain anatomical structures which change with the years both as the result of physiologic processes and disease. The pathologic reactions which the clinician or the radiologist is called upon to diagnose are definitely influenced by the physiology and mechanics of the anatomy of each individual. Accordingly, any classification of chest diseases must be based not only upon the pathologic reactions of diseases but also as influenced by anatomy and by the physiology and mechanics of this anatomy.

The presentation will be made in sequence with the following sections:

Monday:
1. Anatomy of the lungs
2. Physiology and mechanics of the chest and particularly of the lungs

Tuesday:
3. Pathologic reactions with a classification of diseases of the lungs

Wednesday:
4. Illustrations of the different diseases of the lungs and their diagnosis.

Course No. 8. CARDIORADIOLOGY: Samuel Brown, M.D., Cincinnati, Ohio. Two-hour course. Thursday, 8:30 A.M. to 10:30 A.M.

The presentation will consist in the demonstration of roentgenographic signs of diseases of the heart and great vessels as revealed by changes in their position, shape, size, relationship, contour, density, mobility, and motility. Cardiodynamics of the heart and vessels by the roentgen kymographic method will receive special attention. The principles and technic will be illustrated by a simple kymographic model. Roentgen kymograms of the common diseases of the heart and vessels will be exhibited.

Course No. 9. ROENTGEN DIAGNOSIS OF SILICOSIS: W. M. Doughty, M.D., Cincinnati, Ohio. Two-hour course. Friday, 8:30 A.M. to 10:30 A.M.

Films and lantern slides, showing early findings and later complications of silicosis, and some of the other chest diseases which give trouble in the differential diagnosis.

Course No. 10. THE BASIC PRINCIPLES OF PROTRACTED FRACTIONATED EXTERNAL IRRADIATION: Milton Friedman, M.D., New York City. Three-hour course. Sunday, 2 P.M. to 5 P.M.

1. A brief review of the significance of the physical and treatment factors such as voltage, filtration, distance, size of portal, and size of daily dose.
2. Time-intensity factor: the relative effects of low and high dosage rate; optimum number of days for a course of treatment; short intensive *versus* prolonged subintensive course of irradiation.
3. Phenomena associated with the time-intensity factor; significance of missed treatments during various periods in the course of irradiation; destructive and healing phases; the potency of the recovery factor during various periods in the course of treatments; periodicity; acquired radioresistance.
4. Rhythms of administration of radiation dose: constant daily dose; periodicity (Coutard); periodicity (Friedman); pyramided doses; saturation technic; decreasing doses.
5. Specific clinical and radiotherapeutic characteristics of tumors of various sites or origin.
6. Interstitial irradiation following external irradiation; indications; dose; fractionated interstitial irradiation.
7. Histologic changes in tumors of various degrees of malignancy produced by protracted fractionated irradiation; maturation and metaplasia induced by radiation.

Course No. 11. FILM-READING SESSION. M. C. Sosman, M.D., Boston, Massachusetts, and Ross Golden, M.D., New York City. Two-hour course. Sunday, 7 P.M. to 9 P.M.

Those attending the course are invited to bring case reports and radiographs of interest or difficult cases for presentation and informal discussion. Those conducting the conferences will depend upon voluntary submission of material by those enrolled.

Course No. 12. X-RAY THERAPY IN THE TREATMENT OF CARCINOMA OF THE SKIN: J. M. MARTIN, M.D., Dallas, Texas. Two-hour course. Monday, 8:30 A.M. to 10:30 A.M.

A brief review of carcinoma of the skin from 1898 to the present time. Methods of selecting cases, diagnosis, and methods of treatment will be illustrated by means of photographs.

Particular stress will be laid on lesions about the face, with their complications and methods of treatment. Methods for keeping records with a five-year follow-up system will be shown and discussed. The illustrations will be by means of substandard slides and the automatic selectroslide.

Course No. 13. RADIATION THERAPY OF THE LYMPHOBLASTOMAS. B. P. Widmann, M.D., Philadelphia. Two-hour course. Tuesday, 8:30 A.M. to 10:30 A.M.

Lymphoblastomas (including discussion of leukemias) are classified as to pathologic, roentgenologic, and clinical manifestations and characteristics. Special consideration is given to the manifold variations, longevity cycle, and response to irradiation. A detailed review and analysis of technical procedures will be made, with supplementary suggestions and recommendations with particular reference to general management along the lines of regulation and control of the physical tolerance according to a predetermined plan of roentgen-ray dosage.

Course No. 14. THE TREATMENT OF CANCER OF THE BREAST: U. V. Portmann, M.D., Cleveland, Ohio. Three-hour course. Wednesday, 8:30 A.M. to 10:30 A.M., Thursday, 8:30 A.M. to 9:30 A.M.

The anatomy, physiology, and pathology of the breast will be discussed. Differential diagnosis of tumors of the breast and the plan of management will be presented as modified by the extent of the disease. Statistics comparing the different methods of management will be presented and discussed.

Course No. 15. THE TREATMENT OF CARCINOMA OF THE CERVIX: Edwin C. Ernst, M.D., St. Louis, Missouri. Three-hour course. Thursday, 9:30 A.M. to 10:30 A.M., Friday, 8:30 A.M. to 10:30 A.M.

Carcinoma of the cervix is, unfortunately, one of the most common human maladies met with in our daily contacts with cancer, and fortunately is a relatively amenable type of malignant tumor which can be made to respond more favorably if carefully planned radiation management and the necessary clinical considerations are not overlooked. The end-result of this lesion is more directly dependent upon the proper selection of the type and method of x-ray and radium application than almost any other form of malignancy.

The knowledge gained by the grading of the lesion is important but, equally helpful from a prognostic standpoint, is the study and careful analysis of the post-radiation therapy and biopsy prior to the administration of the intracavity radium applications.

Preliminary x-ray therapy followed by adequate radium applications and the relative radiation merits of either method of application will be discussed and analyzed to meet the needs of the many possible distant extensions of the lesion under consideration.

The important procedure of estimating the tumor doses in tissue roentgens by the indirect and direct methods of measurement will be illustrated and discussed. The absolute necessity of employing either or both methods will be stressed. Intracavity tissue roentgen control measurements will be shown.

Practical examples of solving these problems as they are met with in private office procedures and in institutional clinics (Barnard Free Skin and Cancer Hospital) and their management will be presented, contrasted, and compared with the many other possible approaches in use to-day.

Radiation treatment standards continue to remain in a state of flux and individualization in the application of roentgen and radium rays, together with adherence to certain fundamental concepts, are certainly helpful if not essential to the better management of cancer of the cervix.

Course No. 16. ROENTGEN ANALYSIS OF FRACTURES: W. Edward Chamberlain, M.D., Philadelphia. Three-hour course. Sunday, 2 P.M. to 5 P.M.

1. General considerations: The responsibilities of the roentgenologist in the fracture field; the determination of position, including rotary displacements that may be very important yet are frequently overlooked; the causes or cause of non-union; safety considerations; medico-legal aspects; records.

2. Apparatus: Biplane and multiplane fluoroscopes, with motion picture demonstration and exhibition of model; safety considerations.

3. Illustrative cases (from the fracture service of John Royal Moore, M.D., Professor

of Orthopedic Surgery, Temple University Medical School): Part by part review of fractures of hip, thigh, pelvis, spine, etc., from the point of view of their analysis by roentgen methods and avoidance of pitfalls.

Course No. 17. ROENTGEN KYMOGRAPHY: Wendell G. Scott, M.D., St. Louis, Missouri. Three-hour course. Monday, 8:30 A.M. to 9:30 A.M.; Tuesday, 8:30 A.M. to 9:30 A.M.; Wednesday, 8:30 A.M. to 9:30 A.M.

The course includes a brief description of the principles and technic of roentgen kymography in various types of heart disease, particularly valvular disease, myocardial degenerations, pericardial effusions, the forms of constrictive pericarditis, and the detection of coronary artery disease and cardiac infarctions. An attempt will be made to present the material in a clinical manner.

Course No. 18. RADIOLOGY OF THE GENITO-URINARY TRACT: B. H. Nichols, M.D., Cleveland, Ohio. Three-hour course. Monday, 9:30 A.M. to 10:30 A.M.; Tuesday, 9:30 A.M. to 10:30 A.M.; Wednesday, 9:30 A.M. to 10:30 A.M.

Monday: Retrograde pyelography, with demonstrations of the various lesions in which this type of examination seems to be necessary.

Tuesday: The subject of excretory urography will be dicussed, with the technic and indications for its use, and illustrations of lesions on which it is satisfactory.

Wednesday: The Refresher Course will be confined to lesions in which both excretory urography and retrograde pyelography are indicated, with lesions demonstrating the necessity of both methods.

Course No. 19. THE ROENTGENOLOGIC ASPECTS OF THE ARTHRITIDES: L. H. Garland, M.D., San Francisco, California. Two-hour course. Thursday, 8:30 A.M. to 10:30 A.M.

Following a definition of the term arthritis, the author will present a general classification of the arthritides and allied arthropathies. The pathological appearance of the more important forms of arthritis will be discussed. The diagnosis and differential diagnosis of the various types of arthritis will then be outlined, illustrated with roentgenograms, and presented for brief debate. The lack of correlations between the clinical symptoms and roentgenologic findings in common forms of so-called arthritis will be outlined and an attempt will be made to evaluate the usefulness of roentgen examination in the early diagnosis of certain forms of infectious arthritis. The technic and results of the newer forms of roentgen examination of joints by the use of intra- and extra-articular opaque media and mechanical traction will be considered. If time permits, the value and results of roentgen treatment of a few certain specific types of arthritis will be presented and illustrated by lantern slides.

Course No. 20. RADIOLOGIC INVESTIGATION OF THE SPINE AND SACRO-ILIAC JOINTS: Fred J. Hodges, M.D., Ann Arbor, Michigan. Two-hour course. Monday, 8:30 A.M. to 10:30 A.M.

Beginning with a brief consideration of exposure technic, the subject matter covered in this review deals largely with a classified list of the various vertebral abnormalities which may be encountered, the relative frequency of individual lesions, and the roentgenological signs by which they may be recognized. Typewritten outlines indicating the high-lights of vertebral examination will be distributed to members and others in attendance, and lesions in this category will be liberally illustrated with lantern slide material. Emphasis will be placed on the broad scope of this division of roentgen diagnosis rather than unusual or spectacular individual situations.

Course No. 21. RADIOLOGY OF THE SKULL: M. C. Sosman, M.D., Boston, Massachusetts. Two-hour course. Tuesday, 8:30 A.M. to 10:30 A.M.

A lantern slide demonstration, using two lanterns simultaneously, of the commoner lesions of the skull and brain which are characteristic or diagnosable by radiographic examination. A short discussion of the differential diagnosis, with remarks on the prognosis and roentgen therapy in cases in which it is applicable. Slides will be shown and discussed.

Course No. 22. ENCEPHALOGRAPHY AND VENTRICULOGRAPHY: Karl Kornblum, M.D., Philadelphia. Two-hour course. Wednesday, 8:30 A.M. to 9:30 A.M.; Thursday, 8:30 A.M. to 9:30 A.M.

The anatomy of the intracranial cavity with special reference to the pathways of the cerebro-spinal fluid will be reviewed. The indications and contra-indications for the use of air studies in the case of intracranial pathology will be discussed. The presentation of actual cases, with reference to the pathological findings at operation or autopsy, will illustrate the various type of lesions that can be demonstrated by encephalography and ventriculography. Special emphasis will be placed upon the correlation of the clinical and roentgenological findings in the interpretation of encephalograms and ventriculograms.

Course No. 23. MYELOGRAPHY: John D. Camp, M.D., Rochester, Minnesota. Two-hour course. Wednesday, 9:30 A.M. to 10:30 A.M., Thursday, 9:30 A.M. to 10:30 A.M.

This will be a discussion of the various methods of myelography, particularly as relates to the use of iodized oil and air. The normal appearance of the spinal subarachnoid space and the changes resulting from the presence of extradural, intradural, and intramedullary lesions will be considered. The advantages and disadvantages concerning the use of iodized oil and air will be discussed, together with the comparative accuracy of these agents. Iodized oil myelography will be discussed on Tuesday morning and air myelography will be discussed on Wednesday morning. Discussions will be illustrated by lantern slides and moving pictures.

Course No. 24. DISEASES OF BONES OF CHILDREN: Leo G. Rigler, M.D., Minneapolis, Minnesota. Two-hour course. Friday, 8:30 A.M. to 10:30 A.M.

The diseases which produce generalized bone changes, specifically in children, include rickets, renal rickets, scurvy, secondary effects of jaundice and severe liver disease, congenital syphilis, abnormal introduction of heavy metals, excessive intake of vitamins, various blood dyscrasias, and certain tumors. The underlying pathology, the roentgen findings, and differential diagnosis of this group of conditions will be detailed. Illustrative cases will be demonstrated by means of roentgenograms, lantern slides, and diagrams. The congenital anomalies and dyscrasias will not be included in this discussion.

Course No. 25. PHYSICS OF RADIATION (Elementary Course): Edith H. Quimby, M.A., New York City, J. L. Weatherwax, M.A., Philadelphia, and Otto Glasser, Ph.D., Cleveland, Ohio. Eleven-hour course. Sunday, 2 P.M. to 3:30 P.M.; 7 P.M. to 9 P.M.; Monday, 9 A.M. to 10:30 A.M.; Tuesday, 9 A.M. to 10:30 A.M.; Wednesday, 9 A.M. to 10:30 A.M.; Thursday, 9 A.M. to 10:30 A.M.; Friday, 9 A.M. to 10:30 A.M.

Sunday, 2 P.M. to 3:30 P.M. (Glasser): Fundamental considerations regarding matter, electricity, and radiation.

Sunday, 7 P.M. to 9 P.M. (Weatherwax): Sources of radiation, x-ray tubes, and radioactive substances.

Monday (Glasser): Interactions of radiation and matter. Scattered and secondary rays, ionization, absorption, etc.

Tuesday (Quimby): Measurement of quantity and quality of x-rays.

Wednesday (Weatherwax): X-ray physics.

Thursday (Quimby): X-ray dosage.

Friday (Weatherwax): Radium dosage.

Course No. 26. PHYSICS OF RADIATION (Advanced Course): Edith H. Quimby, M.A., New York City, Otto Glasser, Ph.D., Cleveland, Ohio, and Merle Tuve, Washington, D. C. Three-hour course. Tuesday, 9:30 A.M. to 10:30 A.M.; Wednesday, 9:30 A.M. to 10:30 A.M.; Thursday, 9:30 A.M. to 10:30 A.M.

Tuesday (Glasser): Supervoltage generators, cyclotron, van de Graaff, Sloan, etc.

Wednesday (Quimby): Nuclear physics (theoretical), neutrons and artificial radioactivity.

Thursday (Tuve): Nuclear physics (practical). Production and measurement of some of the new radiations.

SPECIAL POST-GRADUATE COURSES FOR RADIOLOGISTS

The University of Minnesota is putting on a Refresher Course on Neurologic Roentgenology on Nov. 13, 14, and 15, 1939. Detailed description of the University's courses for radiologists was published in RADIOLOGY, **33,** 249, August, 1939. Those interested in the matter can obtain full information by writing to William A. O'Brien, M.D., Continuation Center for Post-graduate Study, University of Minnesota, Minneapolis, Minnesota.

COMMUNICATION

THE TISSUE DOSE

There has been a great deal of material published of late by physicists who have attempted to solve the problem of tissue dose. The methods and their accuracy have been somewhat varied, but, on the whole, the results have been in good agreement. There have in some cases been recommendations based on this physical evidence, however, which hardly take into consideration the other phases of this problem, which are much broader in their scope than the mere physical measurement. While it is quite proper for the physicist to limit his work to the field in which he is skilled, the radiotherapist must give attention to all other phases of this subject in applying these measurements and recommendations to practical therapy.

Our main radiotherapeutic objective is to obtain a reproducible effect in the tissues, and the only use—to us—of tissue dose is as a yardstick to measure radiation so as to reproduce a given effect under somewhat different conditions. If our yardstick is calibrated with a degree of precision differing from the precision with which we can measure the biologic effect, *the total precision of our measurement will be that of the less precise of the two.* Physical measurements of depth dose are at a degree of precision approximating ±10 per cent, even if some allowance for the change from phantom to body be made, *provided* the clinical administration of the dose conforms in accuracy to the physically measured dose used in the calculation. But actually, the biologic effect *cannot* be measured precisely enough, and the clinical dose *is not* measured precisely enough, to take advantage of the stated physical accuracy.

Biologic effects under experimental conditions have been measured with accuracies of ±5 per cent or better (for instance, radiation effects on *Drosophila* eggs by Henshaw and his co-workers). But the experimental conditions involved the use, not of individual cases, but group averages of some hundreds of individuals. In no case was the worker able to take a single egg and give a dose which would produce just so much and no more effect. He could, indeed, give a dose which would have no effect, or a dose which would have a lethal effect in all cases, but these extreme instances are the very ones not applicable in clinical practice. Clinically we are always dealing with partial effects on normal and diseased tissues *in an individual*, and the precision with which we can estimate a reaction to a given dose can hardly be placed at greater than ±30 per cent, if it is indeed that high. Even in statistical studies in which dose and various tumor types have been related, precision of ±10 per cent is practically unknown. It is, therefore, not unfair to conclude that, even if our yardstick has a precision of ±10 per cent, our total precision is certainly not better than ±30 per cent, and probably not that good.

Moreover, under clinical conditions we seldom measure our time closer than ±10 per cent, our voltage better than ±5 per cent, and our distance better than ±2 per cent. But *each* of these may mean an error of 10 per cent in determining the dose given, and a total error of 30 per cent is possible. Beside these elements of uncertainty, it is customary in most places to take the dose to the nearest even 10 r, which means that the computation of dose is itself uncertain to about 5 per cent. We can hardly hope that our yardstick of tissue dose measurement will be more accurate, then, than ±20 per cent under clinical as distinguished from physical conditions.

These considerations would seem to warrant some caution in accepting recommendations based on purely physical evidence, for use in practical therapy. For instance, the use of bags of flour or rice, or the employment of wax moulages on the neck, in order to make the conditions approach more nearly phantom measurements, appears to be a refinement almost absurd in the face of gross inaccuracy elsewhere. If some usages based on purely physical evidence are desirable, we must not, therefore, assume that all of them are. On the other hand, an attitude of complete indifference to tissue dose as measured physically is as great an error as over-confidence in it. Our chief problem at the moment is that the biologist has not kept up in the precision of measurement with the physicist, and our effort must be to bolster up this weak point, not to destroy the strong with which we compare it. But remember, *it is nonsense to try to measure to the nearest yard with a micrometer caliper, and in the final analysis the reaction of the patient as determined clinically is the truest measure of roentgen biologic effect we possess to-day. We must never cease,* first, *to be clinicians.*

LEWIS G. JACOBS, M.D.

IN MEMORIAM

HENRY KHUNRATH PANCOAST, M.D.
(1875–1939)

On May 20, 1939, the medical world suffered the loss of a brilliant scientist and one who had consistently exercised a constructive influence in the field of radiology throughout his entire professional career.

Dr. Pancoast was an outstanding member of a small group of pioneers who lived to play a prominent rôle in the development and teaching of the science of radiology. His professional record and whole conduct of life were characterized by honesty, care, moderation, deliberation, and consideration.

Dr. Pancoast, the son of Dr. Seth and Susan George Pancoast, was born in Philadelphia, Feb. 26, 1875. His early education was obtained at Friends' Central School, as his parents were prominent Philadelphia Quakers. After being employed in the field of banking for a short time, he decided to study medicine and in due course received his degree from the University of Pennsylvania, in 1898. He served as a member of the interne staff of the Hospital of the University of Pennsylvania until 1900. After the completion of his internship, Dr. Pancoast was appointed Assistant Instructor in Clinical Surgery and Assistant Demonstrator in Surgery. Subsequently, at the instigation of his Chief, J. William White, M.D., Professor of Surgery at the University of Pennsylvania, Dr. Pancoast entered the field of radiology, and was appointed "skiagrapher" of the University Hospital, in 1902.

Dr. Pancoast's early training was received from Professor Arthur W. Goodspeed, William M. Sweet, M.D., and Charles Lester Leonard, M.D. In the beginning of his work in roentgenology, Dr. Pancoast set up a careful cross-index of his pathologic cases, and in a remarkably short time began to publish papers on his observations. Oftentimes, in recent years, Dr. Pancoast, in his truly modest manner, would tell his associates that he would prefer that some of these early papers had never been written, but any one who might read those articles to-day could not help but be impressed with the value of his early observations.

In 1903, Dr. Pancoast married Clara L. Boogs, who was a most sympathetic and devoted wife, and in many ways assisted him in his work.

In 1905, Dr. Pancoast, Dr. Pfahler, and a few other radiologists under the guidance of Charles Lester Leonard, organized the Philadelphia Roentgen Ray Society. This society has continued to flourish because of the counsel and heritage of such men.

In 1911, Dr. Pancoast was elected secretary, and in 1912, president, of the American Roentgen Ray Society. It was during his presidential year that the University of Pennsylvania made him the first professor of roentgenology in the United States. In this capacity, Dr. Pancoast gradually developed teaching in radiology so that to-day it occupies a prominent place in the curriculum of the Medical School.

In 1916, Dr. Pancoast, with a small group of physicians interested in radium, organized the American Radium Society, and, in 1917, he was elected secretary of that organization and was made its president, in 1919.

During the World War, Dr. Pancoast joined the Navy and contributed in many ways to the development of his specialty in the Naval base hospitals of Philadelphia.

In 1922, he became a member of the Radiological Society of North America, and for many years was an active contributor at its annual meetings and served on many of its committees.

In 1932, Dr. Pancoast was elected Chairman of the Section on Radiology of the American Medical Association. He became a director of the American Society for the Control of Cancer and served on its Executive Committee.

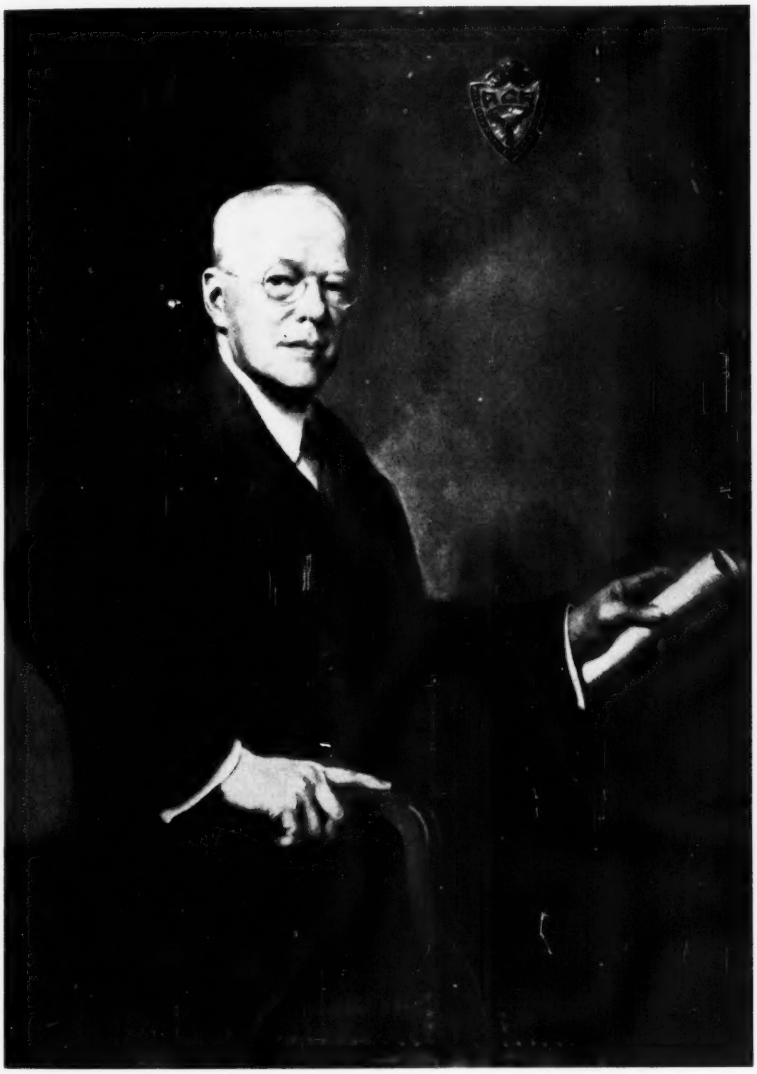
On Sept. 25, 1933, Dr. Pancoast was elected president of the First American Congress of Radiology and three days later was elected president of the American College of Radiology. In 1934, he was made the first president of the American Board of Radiology.

Dr. Pancoast was a prodigious worker; in fact, his work was his vocation as well as his avocation. He published several books and over one hundred original articles on many subjects. His most noteworthy contributions have been on pneumoconiosis, in which subject he was intensely interested.

Dr. Pancoast was a man whom his associates, colleagues, and friends loved, respected, and admired.

It can be said of Henry K. Pancoast that he has fully justified the confidence which his teachers, colleagues, and friends entrusted to him.

EUGENE P. PENDERGRASS, M.D.



From a painting

The late Dr. Henry K. Pancoast.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ATLAS CLINIQUE D'OPHTHALMOSCOPIE PHOTOGRAPHIQUE (Clinical Atlas of Photographic Ophthalmoscopy). Clinical Syndromes of the Fundus of the Eye. By HENRY TILLE, Chief Physician to the Laboratory of Ophthalmalogy and formerly Chief of the Clinic of Quinze-Vingts de Paris; titular member of the Society of Ophthalmology, Paris, and A. COUADAU, formerly Clinical Chief of the Faculty of Toulouse, and Ophthalmologist of the Anti-cancer Center; national correspondent of the Society of Ophthalmology, Paris. A volume of 194 pages, with 202 illustrations. Published by Masson et Cie, Paris, 1939. Price: 280 francs.

RÖNTGENPHYSIK (Roentgen Physics). By Dr. ADOLPH LIECHTI, Professor of Medical Radiology and Director of the Roentgen Institute, University of Berne, with contributions by Dr. Walter Minder, Chief Technician of the Berne Radium Institute. A volume of 308 pages, with 227 illustrations. Published by Julius Springer, Vienna, 1939. Price: 31.80 R.M.

LE CANCER DE L'ESTOMAC AU DEBUT (Early Cancer of the Stomach). A Clinical, Radiologic, and Anatomopathologic study. By RÉNÉ A. GUTMANN, Physician to the Paris Hospitals, IVAN BERTRAND, Director of the School of Higher Education, and TH. J. PERISTIANY, Assistant Consultant in Gastroenterology at the Salpetrière. A volume of 500 pages, with 563 figures. Published by G. Doin & Cie, Paris, 1939. Price: 360 fr. bound.

BOOK REVIEW

DAS WESEN UND DER WERT DER TOMOGRAPHIE (The Method and Value of Tomography). By Dr. W. DEUTSCHMANN, Berlin. Volume 23 of Praktische Tuberkulose-Bücherei (Practical Tuberculosis Booklets). A monograph of 40 pages, with 39 illustrations. Published by Georg Thieme, Leipzig, 1939. Price: 3.00 R.M. (25 per cent discount allowed to foreign purchasers).

The author discusses the history, physics, mechanical principles, and clinical applications of tomography. As early as 1914, Karol Meyer suggested the principle. In 1921, Bocage established tomography as it is known to-day, various modifications having been made by Bartelink, Vallebona, and Ziedses des Plantes. He discusses the types of apparatus in popular use at present. Tomography finds wide application in the field of tuberculosis of the lungs; apical and upper lobe cavities are often demonstrable by this method when they have been overlooked by the routine roentgenologic methods. In looking for suspected cavities, the author suggests the use of six or seven tomographic views, at levels from 1.5 to 2.0 cm. apart. Mediastinal glands are often demonstrable when overlooked otherwise. Cases that have been subjected to collapse therapy can be followed by this method. Malignant and benign bronchial stenosis can be studied and demonstrated. Lung abscesses and bronchiectasis lend themselves to this method. The larynx has been studied by tomography, as well as the skull and skeleton. Portions of the body which from the standpoint of ordinary radiographic technic are difficult to demonstrate, such as the sternum, can often be well shown by tomography. Urography has been expanded by the introduction of this method. The limits of tomography have as yet not been reached, and the author looks forward to an expansion of this field of radiography as the years go by.

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HEART AND VASCULAR SYSTEM

Movement of Roentgen-opaque Deposits in Heart and Valve Areas. II.—The Excursion of the Apex and Base of the Left Ventricle Compared with that of the Left Border. Charles C. Wolferth and Alexander Margolies. Am. Jour. Med. Sci., **197,** 197–201, February, 1939.

A cardiac roentgen kymogram, timed by an electrocardiogram, was made in five cases in which there was calcification in either the mitral or aortic valves, so that the relationship of the movements of the apex to those of the calcifications could be studied.

The important movement of the left ventricle during contraction is shortening of the long axis with extensive movement of the base and apex toward each other. The movement of the left border is not only a relatively small part of the cardiac movement, but also is shown to move outward during the early part of ventricular contraction. Hence, it may fail to reflect the vigor or extent of left ventricular contractions.

The floor of the auricle (roof of the ventricle) does not remain in a relatively fixed position, but is pulled vigorously toward the apex in ventricular systole, while the apex is moving toward the base. This movement would tend to fill the auricles by suction. It may be that the movements of the tissues separating the auricles and ventricles make possible the filling and emptying of the chambers when the movements of the external walls are restricted, as in calcification of the pericardium. One effect of the forcible systolic pull of the root of the aorta toward the apex is that the blood does not have to be propelled as far during systole to enter the aorta, as if the aortic valve were fixed in position.

BENJAMIN COPLEMAN, M.D.

Roentgenology of the Heart and Great Vessels. J. H. Palmer. Canadian Med. Assn. Jour., **40,** 343–349, April, 1939.

The anatomy of the heart and great vessels, from the roentgen aspect, is briefly outlined. Diagnostic methods, fluoroscopy, films made at different angles, orthodiagraphy, multiple slit roentgen kymography, and tomography are described. The author stresses fluoroscopic examination.

The roentgen report should mention first any general enlargement—slightly, moderately, or greatly enlarged—and then proceed to describe enlargement of the individual cardiac chambers and great vessels and any abnormalities of pulsation. The author considers mathematical formulæ for determining enlargement unreliable.

In valvular lesions, the heart almost invariably assumes a certain characteristic shape; in mitral stenosis enlargement of the left atrium, in isolated tricuspid stenosis enlargement of the right atrium, and in aortic regurgitation, enlargement of the left ventricle together with excessive aortic pulsation. Pericardial effusion may reveal, on fluoroscopic examination, a diminution of pulsation of the lower cardiac borders as compared with the pulsations of the aorta. Changes produced by aortic disease are more easily diagnosed from the fluoroscopic findings. In hypertension, cardiac enlargement may be present. Atheromatous coronaries have been visualized. The outstanding and constant feature of heart failure is an increase in the hilar shadows, due to engorgement of the large pulmonary vessels.

Congenital defects often present peculiarly deformed cardiac shadows. Patent ductus arteriosus and interauricular septal defect are characterized by great enlargement of the pulmonic arc. Coarctation of the aorta can produce erosion of the lower margins of the ribs posteriorly.

Normal roentgen findings are possible in the presence of serious cardiac disease and positive findings may add, at times, little of importance to the clinical diagnosis already made, but the correlation of clinical with roentgen findings will extend considerably the field of usefulness of the roentgen ray.

M. L. CONNELLY, M.D.

INFECTION

Roentgen Therapy: An Adjunct in the Armamentarium of the Otolaryngologist and Ophthalmologist in the Treatment of Infections. Lloyd E. Wurster. Pennsylvania Med. Jour., **42,** 506–508, February, 1939.

The most logical theoretical explanation of the value of roentgen therapy in infection, according to the author, is that the x-ray destroys a large number of round cells at the site of infection, liberating antibodies and lysins. In treating an infection about the face, the author gives small doses of unfiltered low voltage therapy and repeats in 24 hours, if necessary.

Chronic infection of the sinuses accompanied by thickened mucous membrane will afford the patient much relief when treated, but proper drainage must be instituted.

In cases of otitis media, without evident cell destruction of the mastoid, the use of roentgen therapy will cause most cases to clear up without operative interference.

Roentgen therapy is the choice in cervical adenitis and when treated before pus formation has occurred will usually cause the swelling to subside. If an abscess formation does occur, it appears to clear up more quickly when roentgen therapy is used.

Mikulicz' disease, parotitis, tuberculous keratitis, and vernal catarrh are amenable to x-ray therapy.

Roentgen treatment of infected tonsils is not advocated unless surgical intervention is contra-indicated.

The author states that diphtheria carriers may be rendered free of infection by roentgen therapy.

JOSEPH T. DANZER, M.D.

Radiation Therapy in the Treatment of Infections. Lewis G. Allen and P. E. Heibert. Jour. Kansas Med. Soc., **40,** 95–101, March, 1939.

The authors discuss the use of radiation therapy in the treatment of various infections. The subject is

covered in a general way, no attempt being made to give specific information concerning the details of technic. Brief mention is made of a wide variety of diseases which have been found amenable to roentgen rays or radium and the results to be expected from these forms of therapy. A bibliography of 32 references is appended.

LESTER W. PAUL, M.D.

THE INTESTINES

Decompression of the Small Intestine in the Treatment of Intestinal Obstruction. Charles G. Johnston, Grover Cleveland Penberthy, R. J. Noer, and J. C. Kenning. Jour. Am. Med. Assn., **111,** 1365–1367, Oct. 8, 1938.

The rôle of distention as an important factor in the initiation of conditions which lead to a fatal outcome of intestinal obstruction has been well demonstrated within the last few years. The beneficial effects of gastric or duodenal suction is based largely on the proposition that with relief of distention not only does the patient become more comfortable, but in many cases the release of tension above the obstruction permits passage of the intestinal contents through the narrowed lumen of the bowel. The rôle of distention in the initiation of vomiting, the common precursor of loss of fluid and salt in cases of intestinal obstruction, has been well studied and it has been shown that it is possible to produce symptoms and sequelæ of intestinal obstruction in animals by distention, even though obstruction is not present.

Beneficial effects from enterostomy in cases of intestinal obstruction likewise attested the efficacy of decompression of the distended bowel in the control of intestinal obstruction. Enterostomy when it decompresses the bowel directly above the site of obstruction is a surer method than is gastric or duodenal suction, but the operation entailed frequently negates this advantage.

With encouragement from the results from the use of the above-named procedures, a tube was passed into the small intestine of a patient with intestinal obstruction who had refused operation. The tube passed with greater ease than was anticipated and decompression of the distended intestine was effected. This procedure in effect was tantamount to an enterostomy without the trauma of an operation. A tube (16 to 18 gauge) from 10 to 12 feet in length was passed through the nose. An inflatable balloon was attached to the end of this tube. When the tube was well into the duodenum the balloon was partially inflated, and peristalsis pulled the tube and the balloon past the ligament of Treitz. At this point the balloon was fully inflated, to a capacity of from 40 to 60 c.c., so that the intestine could act on a larger volume. The reason for not inflating the balloon fully in the duodenum was twofold: (1) If inflated fully, the balloon and tip occasionally pulled back into the stomach, and (2) if too fully inflated the balloon passed with difficulty the fixed portion of the upper part of the intestine, the lower part of the duodenum. As the tube progressed down the intestinal tract, fluid and gas were aspirated from the dilated intestine ahead of the balloon. Failure to decompress ahead of the balloon will result in stoppage of the forward progress of the tube. The cases reported were those in which paralytic ileus associated with other conditions threatened the life of the patient In addition, the authors used intubation prophylactically in a large number of cases.

The advantages and disadvantages of the method are carefully reviewed and detailed.

It is felt that intubation of the small intestine in selected cases has a definite place in the care of patients suffering from intestinal obstruction.

CHARLES G. SUTHERLAND, M.D.

Carcinoma of the Jejunum: Acute Intestinal Obstruction. F. Mitchell Heggs. British Jour. Surg., **26,** 532–539, January, 1939.

Carcinoma of the jejunum is an uncommon finding, with an exceedingly small percentage of cases reported from the large clinics. The tumor tends to be polyploid in the younger patients, with resulting acute obstruction from intussusception. The usual form is the slowly growing ring neoplasm of the scirrhous type and this either ulcerates or undergoes colloid degeneration. The average age of the reported cases has been between 30 and 40 years, the youngest being 28. Diagnosis depends on symptoms of high intestinal obstruction, negative radiologic evidence of disease of stomach and duodenum, progressive anemia, occult blood in the stools, and persistent loss of weight. Obstructive symptoms are present for a period varying up to six months and occur from three to four hours after meals. Abdominal cramps are referred to the subumbilical region and are associated with a feeling of distention relieved by vomiting. Anemia is a marked feature and the hemoglobin may descend as low as 35 per cent, with a red cell count of 3,000,000. Positive radiologic evidence was found in a small percentage of cases and based on stenosis of the intestinal lumen at the site of the carcinoma with proximal dilatation.

The author reports three cases. The first was a man, 27 years of age, who had symptoms of acute obstruction. At operation a neoplasm of the ring type with incipient perforation was found. The pathological report was spheriodal-cell carcinoma. The second case was that of a woman, aged 53, and was typical of the disease. She complained of epigastric pain four hours after meals, relieved by vomiting and anorexia. There was also marked anemia and loss of weight. Duration of symptoms was about two years. Gastrointestinal x-ray examination revealed no pathology but examination of the colon following a barium enema showed gas-filled distended intestine above the transverse colon, with the striations characteristic of small intestine obstruction. Operation revealed ring-type tumor of the jejunum which almost occluded the lumen and, on section, proved to be adenocarcinoma. The third case was that of a man, aged 26, with a history of three months' flatulence, abdominal pain, anemia, and weight loss. Adenocarcinoma of the jejunum with

widespread metastases were found at operation; the outcome was fatal.

MAX CLIMAN, M.D.

The Value of X-ray Study in Acute Bowel Obstruction. James F. Case. Illinois Med. Jour., **74,** 326–330, October, 1938.

The author advises that a film be made in all suspected cases of bowel obstruction to reveal distended coils of small bowel. These may show up as distended coils in a paralleling step-ladder effect or in a herring-bone or ribbed aspect. Such a shadow, as long as 5 cm., if well distended, is highly suggestive of ileus. However, if the obstruction be in the large bowel a distended colon will be visible.

In case the scout film fails to show enough to make a definite diagnosis, an opaque enema should next be given to rule out large bowel obstruction. Also, the distended colon may now make visible loops of distended small bowel that were overshadowed or distorted by the large bowel. If still in doubt, a small amount of opaque material may be given orally. Umbrathor, an aqueous solution of thorium dioxide, is advised, as it does not precipitate. Since some obstructive cases, especially those not immediately post-operative, may not contain enough gas in the small bowel to distend the loops, the opaque material given orally may show in the film the exact site of obstruction or definitely rule it out.

The author especially calls attention to the ready availability of such x-ray study: the small amount of disturbance to the patient: the rapidity with which the information can be obtained; the harmlessness of such procedures; the value of the ability to determine dilated loops of bowel; the differentiation of gas in the small bowel from that in the colon; the value of estimating the actual caliber of the intestinal loops thus visualized, and, mainly, the confirmation of the fact of ileus before proceeding to surgery.

WILLIS A. WARD, M.D.

A Case of Giant Megasigmoid. E. Dechambre, S. Dechambre, and J. Nebout. Bull. et mém. Soc. de radiol. méd. de France, **26,** 380, 381, May, 1938.

A case of megasigmoid which measured 18 cm. in diameter on the radiograph was observed by the authors. The patient had a history of constipation since infancy, with two episodes of fecal impaction following a month without a bowel movement. Although the patient was having, with the aid of laxatives and enemas, fairly regular bowel movements, this large sigmoid was filled with a fecalith the size of an adult's head.

S. R. BEATTY M.D.

THE JAWS

Radiographic Examination of the Superior Part of the Ascending Ramus of the Jaw. F. Arcelin. Bull. et mém. Soc. de radiol. méd. de France, **26,** 372, 373, May, 1938.

In view of the recent interest in methods of radiography designed to make certain planes of the body visible by blurring others, it is interesting to recall a method applicable to certain skeletal details. For instance, it is possible to obtain excellent views of the ascending ramus of the jaw without the necessity of oblique projections, merely by reducing the target-film distance to a minimum. Detail of structures on the side nearest the film will be good, while that of structures nearest the tube will be hardly visible.

S. R. BEATTY, M.D.

Diagnosis and Treatment of Cystic Tumors of the Jaw. Norman C. Ochsenhirt. Pennsylvania Med. Jour., **42,** 784–786, April, 1939.

Cystic tumors may arise from the epithelial cells which enter into the formation of teeth, or from trauma. The most common are:

(1) The radicular cyst which is due to an infection stimulating cells of the paradental membrane. These show on x-ray examination as a sharply outlined radiolucent area associated with a devitalized tooth.

(2) Follicular, or dentigerous, cysts are due to a proliferation of the cells of the enamel organ. They appear on x-ray examination as a unilocular cyst and may contain a partially formed tooth.

(3) Adamantinomas show on x-ray examination as a multilocular tumor. They are believed to be formed by cells of the inner layer of the enamel organ.

(4) Hemorrhage in the bone because of trauma, the formation of a hematoma, and the absorption of the spongy bone result in traumatic cysts.

JOSEPH T. DANZER, M.D.

Three Unusual Affections of the Jaws. George T. Hankey. Proc. Royal Soc. Med., **31,** 1137–1144, July, 1938.

By citing three cases in which an accurate clinical diagnosis was not possible, radiographs were inconclusive, and the diagnosis was disclosed only by the pathologic findings, the author illustrates the importance of biopsies in all cases of cysts of the mandible.

The first case was that of fibro-myxo-sarcoma involving the ascending ramus, angle, and posterior third of a mandible, showing clinically only a slight soft enlargement in this region. Radiographic examination revealed a large multilocular cavity simulating a cyst. It was successfully treated by x-ray followed by excision. Osteitis fibrosa was ruled out clinically.

The second case clinically and radiographically resembled a dental cyst of the upper molar area involving the entire antrum, except that the inner wall was expanded as well as the outer, an uncommon finding in cyst. There was no apparent cause for dental cyst (no carious tooth, septic stump, or retained root). Pathological report: a few trabeculæ of basal-cell carcinoma were seen in the squamous epithelial lining of the cyst.

The last case was one of xanthomatosis or lipoid granulomatosis of the mandible (Schüller-Christian

syndrome). The only clinical evidence was a hard painless enlargement of the right body of the mandible, and associated polydipsia and polyuria. Radiographs suggested multilocular cyst. Later there was some tenderness over the area and diffuse rarefaction of the mandible on the radiograph. The skull and other bones were normal. Pathologic examination revealed lipoid granuloma of the jaw. Radium treatment improved the condition, and pituitrin controlled the polyuria.

RAY A. CARTER, M.D.

THE KIDNEYS

The Value of Examination of the Kidneys in the Upright Position. C. Lepoutre. Bruxelles-méd., **18,** 1417–1426, Sept. 4, 1938.

It is essential to examine a patient, suspected of renal disease, in the upright as well as in the supine position, clinically and radiographically. Disturbances of mobility, demonstrated by these maneuvers, are of importance in the diagnosis of renal or perirenal pathology.

The observation of fluid levels in the kidneys is possible only by radiography in the upright position. Such fluid levels are important as an index of renal stasis.

S. R. BEATTY, M.D.

Renal Carbuncle. Harry M. Spence and L. W. Johnston. Ann. Surg., **109,** 99–108, January, 1939.

The authors review 35 recent cases of carbuncle of the kidney and present their own case. The presented case was that of a white male, 13 years of age, with chills and fever of three weeks' duration, without urinary symptoms and with a negative urine. Intravenous urography revealed a filling defect in the region of the middle calix of the right kidney.

At operation, the carbuncle was partially enucleated while the remainder was incised and drained. The convalescence was uneventful. The authors feel that urography is the greatest single objective aid in the diagnosis of renal carbuncle.

JOHN G. MENVILLE, M.D.

The Radiological Findings in Two Cases of Traumatic Rupture of the Kidney. A. S. Johnstone. British Jour. Radiol., **11,** 736–738, November, 1938.

Brief summaries of the case histories of two patients who had injuries to the abdomen producing rupture of the kidney, with massive hemorrhage, are given. The radiographic examination shows obliteration of the psoas line and kidney outline on the affected side.

S. J. HAWLEY, M.D.

KYMOGRAPHY

Kymography as an Aid in the Differential Diagnosis of Mediastinal Tumors. A. Meyer. British Jour. Radiol., **11,** 436–443, July, 1938.

Kymography, for the present at least, is of circumscribed value. This is possibly due to the fact that we cannot yet interpret all we see. So far, it has been useful in the differential diagnosis between aneurysm and mediastinal tumor. Aneurysms tend to show movement, newgrowths do not. What movement is seen in aneurysms is in phase with the aortic pulsations, while that in newgrowths shows a lag. The portion of the aneurysm which is pulsating shows an upper horizon and a lower sloping line in the notch. Newgrowths tend to produce a more rounded outline with both lines sloping. Shadows of aneurysms merge with the aortic shadow. The shadow of the pulsating aorta can be seen frequently through the shadow of the newgrowth. Often clearer pictures can be obtained by keeping the grid stationary and moving the film, and often more satisfactory results follow the use of the grid obliquely. Several illustrative films are reproduced.

S. J. HAWLEY, M.D.

THE LARYNX

The Laminagraph in the Diagnosis of Diseases of the Larynx. A. Pagani. Röntgenpraxis, **11,** 137–146, March, 1939.

Lateral examination has been used as a diagnostic help for diseases of the pharynx and larynx. The information gained by it has been limited. Only lately has it been possible to gain considerably more roentgenologic help in these cases by using the laminagraphic method.

Some authors have reported findings obtained by this late method. The best laminagraphic films are made at a level of from 1.5 to 3.5 cm. below the anterior edge of the larynx, with the patient in a supine position. The best position for the vocal chords is that in e- or u-phonation. Films are reproduced which demonstrate quite well the normal structures of the larynx. Pathologic changes seem to be evident in most cases in which there is an infiltrating lesion. In some of these cases, particularly in carcinomas, the examination by the laryngologist does not reveal the extent of the invasion. The information gained by the laminagraphic method is, according to the authors, a very definite help.

HANS W. HEFKE, M.D.

A New Series of Planigraphs of the Cancerous and Non-cancerous Larynx. Canuyt and Gunsett. Bull. et mém. Soc. radiol. méd. de France, **26,** 29–39, January, 1938.

Planigraphs of the larynx and adjacent structures are invaluable additions to the diagnostic armamentarium of the radiologist and laryngologist. The frontal view can be obtained readily by this method. Frontal planigraphs should be taken in phonation. To secure the best definition the authors recommend the phonation of "i" or "o." Several cases illustrating congenital abnormality, benign tumors, recurrent paralysis, tuberculosis, traumatic hemorrhage into the larynx, syphilis, and cancer of the larynx, intrinsic and extrinsic, are presented with four reproductions of planigraphs.

S. R. BEATTY, M.D.

THE LUNGS

Problems Associated with the Clinical Recognition of Pulmonary Hypertension. Thomas J. Dry. Minnesota Med., **21,** 535–542, August, 1938.

The clinical recognition of pulmonary hypertension depends on the recognition of secondary effects resulting from its presence. The physiologic purpose of the right side of the heart is to convey venous blood to the alveolar system of the lungs, where gaseous changes occur. The pulmonary arterial tree is endowed with a vascular area and a capillary bed, greater than ordinary functional demands can exceed. Experiments have shown that from 52 to 66 per cent of the pulmonary circulation could be cut off without significant variation in the general pulmonary condition. The point at which failure occurs is sharply defined and beyond this point collapse is precipitated by even a minute increase in arterial obstruction. Any mechanism which leads to increased pressure in the pulmonary circuit increases the work of the right ventricle and, if sustained, will lead to hypertrophy of that chamber. When the right side of the heart fails there is resultant edema and venous congestion.

ETIOLOGIC FACTORS

Mitral Stenosis.—Oxygenation is not interfered with until compensation fails, because the obstruction is beyond the alveolar system. Enlargement of the left auricle results.

Failing Left Ventricle.—Results in a similar chain of events. The right ventricle is compelled to contract against an increasing load.

OBSTRUCTION WITHIN THE PULMONARY CIRCUIT

(1) The main pulmonary vessels: (*a*) Acute cor-pulmonale. Sudden closure of a large pulmonary branch results in sudden strain on the right ventricle. (*b*) Thrombosis of the pulmonary artery.

(2) Small and medium sized pulmonary branches (*a*) sickle-cell anemia; (*b*) carcinomatous lymphangitis; (*c*) schistosomiasis.

(3) Pulmonary arterioles: (*a*) secondary pulmonary arteriosclerosis from a variety of causes; (*b*) primary pulmonary arteriosclerosis (rare).

(4) Capillary system: (*a*) Emphysema and asthma —hypertrophy of right side of heart—"emphysema heart" (destruction of interalveolar walls of lung, increase in capillary resistance). (*b*) Kyphoscoliosis—mechanical kinking of great vessels, atelectasis, chronic bronchitis, compensatory emphysema. (*c*) Arteriovenous shunts—patency of ductus arteriosus; septal defects; Lutembacher's disease—mitral stenosis with patent foramen ovale; tetralogy of Fallot; acquired arteriovenous shunt.

The symptoms of the condition are discussed, chief among them being dyspnea and cyanosis. The roentgen picture includes a prominent pulmonary conus, an enlarged right ventricle and auricle, and unusually clear pulmonary fields. There is hilus pulsation at times, and absence of enlargement of the left auricle.

The more proximal the obstruction, the greater the effects.

PERCY J. DELANO, M.D.

Spontaneous Interstitial Emphysema of the Lungs. Johnson McGuire and William B. Bean. Am. Jour. Med. Sci., **197,** 502–509, April, 1939.

Rupture of alveoli or bronchioles, with escape of air into the interstitial tissues, constitutes interstitial emphysema of the lungs. The escaped air may travel toward the hilum and enter the mediastinum, or, perhaps more commonly, extend peripherally and cause sub-pleural bleb formation. Such a bleb may rupture and produce a pneumothorax.

The spontaneous type, described by Hamman, is characterized by the sudden development of severe pain in the chest without antecedent trauma or unusual effort. The presence of a crunching, crackling, bubbling sound, which may vary in quality and intensity from time to time, over the heart with each contraction is pathognomonic. There may be disappearance or decrease in the width of cardiac dullness. Subcutaneous emphysema and occasionally a pneumothorax may be present.

Two cases are reported, one occurring spontaneously, and the other following a difficult labor in a patient with rheumatic heart disease.

BENJAMIN COPLEMAN, M.D.

PREGNANCY

The Pelvic Joints during Pregnancy and Labor. Donald J. Thorp and William E. Fray. Jour. Am. Med. Assn., **111,** 1162–1165, Sept. 24, 1938.

X-ray studies have engendered in recent years a renaissance of attention not only to joints of the pelvis but also to a greater precision in pelvimetry, the mechanics of pelvic inclination, cephalometry, and the anthropologic significance of pelvic types.

Interspersed throughout the many splendid contributions to osteology and mensuration of the female pelvis are scores of reports on the spontaneous separation of the symphysis during labor. Frequent reports of sacro-iliac trauma are also available. This report was not concerned with the obviously traumatic separation of the symphysis; the observations were confined entirely to physiologic diastasis.

A review of the literature revealed descriptions of normal sacro-iliac separation in cows at term, and reflected on a potentially similar phenomenon in woman. It is common knowledge that the guinea pig and other lower animals undergo physiologic separation of the symphysis in labor. Some observers found no pelvic diastasis; some found increased mobility in the joints of pelves during pregnancy; some noted a constant widening of the sacro-iliac spaces during pregnancy, while others stated that additional separation of the pelvic bones in labor was very slight as observed in a few cases. Other observers concluded that some inherent weakness of the joints must pre-

exist; that there was no relationship between the amount of symphysial widening and pelvic type, *i.e.*, gynecoid, android, anthropoid, platypelloid, or flat, but that relaxation of the ligaments and joints was greatest in the last half of pregnancy.

Roentgenographic studies suggested that contracted pelves, especially the justominor and funnel varieties, because the expulsive force acts in a narrow transverse diameter, predisposed to separation of the pubic bones; that the symphysis widens an average of seven or eight mm. in pregnancy, and that the maximum separation is reached between the fifth and the seventh month. In contrast, others were unable to demonstrate any change in the pubic articulations of 80 consecutive women and concluded that any increase in the span of the pelvis takes place only during labor.

Thorp and Fray studied a series of patients who were roentgenographed near term and again, in identical positions, during the first stage of labor, to determine whether any intrapartum separation of the pelvic joints occurred or whether physiologic separation might effect an increase in the area of the superior strait which might expedite the course of the labor. Their technic is described in detail. Seventy-eight cases were analyzed. Those involving complications of pregnancy or labor were discarded and not included in this total. X-ray pelvimetry revealed no well-defined deviations from normal in the series. Thirty-four (43.6 per cent) were shown to undergo definite diastasis of the symphysis; the average span in the articulations was five millimeters, while one patient had a 12-millimeter symphysial separation. In a few patients, widening of the sacro-iliac joints was observed when no separation of the symphysis occurred. However, separation was usually found in all three articulations. The right sacro-iliac span was commonly wider than the left. This asymmetry of mobilization was not satisfactorily explained. Intrapartum changes in the area of the superior strait could not be demonstrated as a result of separation in any of the roentgenograms made by the authors.

CHARLES G. SUTHERLAND, M.D.

Roentgenographic Studies of the Urinary Tract during and after Pregnancy. Stanley R. Woodruff and Arthur H. Milbert. Jour. Am. Med. Assn., **111**, 1607–1611, Oct. 29, 1938.

This is a review of the salient features stressed in several recent contributions to the literature, with the addition of several of their own concepts gained from a study of 60 consecutive unselected normal pregnancies. In limiting their study to intravenous (excretory) urography, the authors intended to investigate the physiology of the upper urinary tract free of any mechanical intervention. Particular stress was placed on studies made with the patient in the upright position, since the authors believed that renal mobility and nephroptosis were vital factors in predisposing to complications. Each patient was investigated from a medical and an obstetric standpoint and was apparently normal. Urinalysis in each instance was likewise free of evidence of any pathologic conditions. The stage of pregnancy when first seen varied from one to nine months.

In all patients, a plain roentgenogram was made prior to the injection of 20 c.c. of diodrast. After the injection, urograms were made with the patient in the supine position at intervals of five, 30, and 60 minutes. One was made with the patient in the upright position at the 15-minute period. Maximum excretion of the dye was most often noted at the end of 30 minutes; the majority of the five-minute urograms showed well delineated pelves.

When possible, excretory urography was carried on at monthly intervals. In several instances five studies, as outlined, were obtained during the antepartum and postpartum investigation of the patient. The pregnant woman was found to tolerate the injection well, and no apparent ill effect was noted on the fetus *in utero* or the newborn, either from the drug or from the exposure to roentgen rays.

Analysis of the urograms revealed observations that coincided with those of previous studies. Progressive dilatation of the upper part of the urinary tract, more marked on the right side, with redundancy and lateral displacement of the ureters, was present in the majority of instances. Pre-existing nephroptosis was partially corrected during pregnancy but was exaggerated once the mechanical support of the gravid uterus was removed. The etiology of dilatation of the ureter and pelvis in the pregnant state was felt to be chiefly mechanical.

The terms "pyelitis of pregnancy" and "hydronephrosis of pregnancy" were considered misnomers. In the former, an infective process was engrafted on some pre-existing lesion, usually obstructive in nature, in the majority of instances. The latter term is a poor one to describe a condition which, in the majority of instances, represents an obstructive uropathy, transient and physiologic in nature, which returns to normal shortly after delivery.

From their observations these authors conclude that most pregnant women with no previous obstructive lesions will go through the period of gestation uneventfully, while those who do experience difficulty have had a condition which antedated gestation.

CHARLES G. SUTHERLAND, M.D.

PYELOGRAPHY

The Lateral Pyelogram as a Diagnostic Aid in Perinephric Abscess. John G. Menville. Jour. Am. Med. Assn., **111**, 231–233, July 16, 1938.

The disappearance of the psoas muscle outline and a poorly defined outline of the kidney on the affected side have been described as characteristic of perinephric abscess. Peacock (1929) stressed the fact that a retrorenal or a retroperitoneal mass producing an anterior and a lateral displacement of the kidney and ureter could be demonstrated by stereoscopic roentgenograms; in his opinion, lateral roentgenograms would show the same displacement, but such a proce-

dure offered too many difficulties. Mertz and Hamer (1934) demonstrated the value of lateral pyelograms in urologic diagnosis, but they did not mention perinephritic abscess.

The author made a preliminary report on the use of the lateral pyelogram as an aid in the diagnosis of perinephritic abscess and reports now three cases in which lateral pyelograms presented a uniform, anterior, arc-like displacement of the kidney and ureter on the affected side in perinephric abscess. Postoperative lateral pyelograms in the same cases showed the kidneys and ureters to be in normal position, with no evidence of anterior displacement. A lateral pyelogram in another very early case of perinephritic abscess showed a minute anterior displacement of the kidney and ureter.

CHARLES G. SUTHERLAND, M.D.

RADIATION

Notes on the Biologic Effects of Densely Ionizing Radiation. K. G. Zimmer and N. W. Timofeeff-Ressovsky. Phys. Rev., **55,** 411, Feb. 15, 1939.

This concerns the biologic difference to be expected by very great intensities of radiation produced by high current x-ray tubes, contrasted with the high columnar density of ionization produced by neutron rays. The authors argue: The dosages to produce gene mutations are about 1,000 r, providing ionization of every hundred millionth atom. However, the experimental results for target volume for gene mutations indicate about a hundred to a million atoms. Therefore, for a given total number of ionizations per cubic centimeter, one would expect more mutations if the ionizations were evenly distributed through the volume than one would expect from great crowding along the track of ionization, such as one sees from neutron rays where the columnar density of ionization is about a hundred times larger than for the secondary recoil in photo-electrons from x-rays and gamma rays. The writers conclude, therefore, that one can expect a differential biological action between neutron rays and roentgen rays not only for reactions requiring two ionizations in the same target volume, but also for one-hit reactions. A figure comparing the production of mutations per roentgen of dosage for neutron rays compared to roentgen rays is given.

ROBERT R. NEWELL, M.D.

RADIOTHERAPY

Terminology to be Used in Radiotherapy. Marquès. Bull. et mém. Soc. de radiol. méd. de France, **26,** 418–421, June, 1938.

Despite a tendency to use the term "radiotherapy" to apply to roentgen therapy alone, it should include the use of other radiations or electromagnetic vibrations, exclusive of electrical currents. These include Curie therapy, roentgen therapy, Bucky therapy, and actino-therapy, including the range of wave lengths between ultra-violet and infra-red. The longer Hertzian waves are not included, as they are used only to induce currents of high frequency.

The term "penetration" is often used ambiguously, and only a knowledge of the coefficient of transmission at a depth gives us a true idea of the coefficient of penetration. Roentgen rays at 300 kv. have, for instance, a low coefficient of penetration if used on small fields at short focal skin distances, and although the radiation used in Curie therapy is penetrating, actual penetration depends on filtration and distance from the skin.

S. R. BEATTY, M.D.

RADIUM

The Measurement of the Dose on Radium Applicators. E. Hasché and J. Bolze. Strahlentherapie, **63,** 701, 1938.

Photographic methods of determining radium doses in r have been described by Holthusen, who uses a cube of wood, and Friedrich, who uses a cube of water. The authors experimented with air as the absorbing material. In order to allow for any difference in the results due to the absorbing medium, they insert a constant k in the relation 1 mg.-hr./cm. $= k \times 8.0$ r. The method of preparing the calibration films and the results of their comparisons between photographic and electrometric determinations are given. It appeared that the method is practical and has the advantage of making possible the measuring of soft and hard gamma rays as well as beta rays in r.

ERNST A. POHLE, M.D., Ph.D.

The Discovery of Radium and Radio-active Substances and its Significance for the Treatment of Uterine Carcinoma. A. Döderlein. Strahlentherapie, **63,** 403, 1938.

In *Strahlentherapie,* **63,** Nov. 26, 1938, which is dedicated to Pierre and Marie Curie, the author gives a brief historical sketch of the development of the therapeutic use of radium as related to the treatment of uterine carcinoma.

ERNST A. POHLE, M.D., Ph.D.

Dosage Considerations with Radium Surface Applicators of Small Area. J. E. Roberts. British Jour. Radiol., **11,** 755–761, November, 1938.

This is an analysis of some of the problems which arise in applying the rules of dosage to flat applicators of less than 10 sq. cm. The distribution of radium in small applicators is apt to be carelessly done, giving rise to great error. The simplest method of overcoming this difficulty is to use radon sources. A useful procedure is to stagger the tubes to allow for the inactive ends of the tubes, or to make the applicator larger than the area to be treated. The rule of peripheral distribution breaks down for very small applicators. This

can be partially overcome by irradiating with a point source at a distance no less than 1 cm.

The choice of radium–skin distance is governed by the depth of the lesion and economic considerations. There is an advantage in the larger radium–skin distances except for the most superficial distances. With applicators less than 1 cm. in thickness, there is marked falling off of the dose at the edge as compared with the center. One of the greatest sources of error in use of small applicators is in estimating the radium–skin distance. This is particularly noticeable where the area to be treated is curving, as on the face or neck. Great care must be used in making and placing the applicator. An increase in radium–skin distance of 1 mm. will produce a 10 per cent reduction in dose.

The use of standard applicators for routine treatments is suggested to prevent these errors in a large measure.

S. J. HAWLEY, M.D.

A New Method of Irradiation by Means of Moving Radium Applicators. K. Mayer. Strahlentherapie, **64,** 134, 1939.

In 1913 Mayer published the first paper dealing with the use of a rotating x-ray tube in therapy. The author has used this same principle in radium therapy and relates the advantages of the method. It requires relatively small amounts of radium and the necessary apparatus can easily be constructed at moderate cost.

ERNST A. POHLE, M.D., Ph.D.

Measurements in r on Telecurietherapy Apparatus. A. Gunsett and G. F. Gardini. Strahlentherapie, **64,** 149, 1939.

The authors describe their radium bombs containing three and five grams of radium element, respectively, which are used at focal distances of 11 and 15 cm. An ionization instrument designed by Pychlau permits the calibration of the output in r. The five-gram radium bomb, if filtered through 1 mm. Pt and 0.5 mm. Cu + 1 mm. Al, to absorb the secondary rays of the lead walls, delivers 142.6 r per hour in air. This drops to 87.5 at five cm., and to 56.5 r at 10 cm., if measured in a paraffin-sugar phantom. The depth dose percentage at 10 cm. is 31 per cent. Similar data are furnished for the three-gram bomb; the depth dose percentage there is 25.8 per cent. Clinical observations showed that after the application of 5,803 r during 35 exposure hours covering a period of a month, an erythema appears, which is followed by desquamation.

ERNST A. POHLE, M.D., Ph.D.

Problems in Radium Dosimetry. H. Smereker. Strahlentherapie, **64,** 492, 1939.

A cylindrical ionization chamber was constructed by the author in such a manner as to permit the exchange of the wall material. This made possible the study of the relationship between ionization and wall material when using gamma rays of radium. With graphite as wall material, it was found that 1 mg.-hr. at 1 cm. distance corresponded to 8.2 r. Absorption measurements carried out in cellon showed that gamma rays (0.5 mm. Pt filter) produce secondary electrons the average speed of which corresponds to that of primary beta rays emitted from a radium emanation glass capillary.

ERNST A. POHLE, M.D., Ph.D.

A Two-gram Radium Unit. F. L. Warburton. British Jour. Radiol., **11,** 762–766, November, 1938.

A brief description of the new unit containing two grams of radium at the Middlesex Hospital is given. The mounting, movements, and the radium-bearing unit is covered. There is a note as to the dosage rate, and the depth dose obtained.

S. J. HAWLEY, M.D.

THE RECTUM

Radiological Examination in Surgical Affections of the Rectum. Paulo de Almeida Toledo. Ann. paulis. de med. e cir., **37,** 71–90, January, 1939.

This paper is part of a series of conferences on diseases of the rectum, and is devoted to the roentgenologic aspect and the usefulness of the x-rays in diagnosing rectitis, polypi, tumors, stenosis, congenital and acquired malformations, fistulæ, and diverticula. The writer does not limit his discussion to the rectum as one would suspect by the title, but extends the subject to include the sigmoid.

The normal roentgenograms of the lower segment of the large bowel, after partial emptying, will show plainly the folds of the mucosa, which will appear as alternating light and dark furrows running parallel to the intestinal walls. When ulceration exists, the normal pattern of the furrows will be altered by circumscribed deposits of the contrast medium used in the enema, showing a translucent inner portion surrounded by an opaque ring. (Edema of the mucosa is characterized by widening greater prominences of the mucosal fold that will encroach into the lumen of the bowel, diminishing its capacity.) When the intestinal wall is the seat of an infiltrating process, whether acute, chronic, inflammatory, hypertrophic, or neoplastic, there is always paralysis or rigidity, accompanied by cicatricial constriction of the intestine, reducing its caliber and altering the normal mucosal relief. To diagnose this condition, fluoroscopic examination or serial roentgenographic films are essential to differentiate it from spasticity of the bowel, the latter being only transitory. As an important point in diagnosis, the author emphasizes the loss of elasticity of the walls, which become rigid and markedly reduced in caliber.

The author describes bundles of the circular muscular fibers along the colon, these being located above the cecum distal to the hepatic flexure, proximal to the splenic, at about the sigmoid–colonic junction, in the sigmoid and rectum. These bundles act as sphincters,

and failure to relax causes dilatation of the proximal portion of the bowel, determining a localized megacolon. Section of the bundle is the logical surgical treatment. Radiologic exploration is useful, not only to diagnose but to determine the offending bundle.

The remaining surgical affections are well handled. Attention is called very wisely to the fact that radiologic explorations of the rectum cannot have the accuracy of biopsy, nor be as effective as direct inspection, but are certainly extremely useful in localizing tumors.

ANTONIO MAYORAL, M.D.

REGMOGRAPHY

Regmography. Pietro Cignolini. Radiol. Med., **26,** 44–51, January, 1939.

Professor Cignolini writes of a method of making serial roentgenograms which was first presented by him in 1934 and to which he gave the name of regmography. The method consists in making successive exposures of a part through an opening on a lead sheet, protecting the remaining portion of the film. The cassette holding the sensitive film is placed behind the lead sheet, the patient in front, and the exposures are made in rapid succession while the films, following a uniform movement, present an unexposed portion to the intermittent flashes of rays. The principle is very similar to the making of moving-picture films, except that the number of exposures is much less. Each individual exposure represents one stage of the organ or portion of an organ exposed.

The author has used regmography extensively in studying the apices of the lungs during coughing, and believes the method to be of practical use and to offer many possibilities.

ANTONIO MAYORAL, M.D.

ROENTGEN RAYS, BURNS AND INJURIES

Knowledge of Radiation Injury of Human Lung. R. Bauer. Strahlentherapie, **64,** 249, 1939.

The author reports in detail a case of x-ray injury of the lung with fatal outcome. The patient had a mediastinal tumor extending into the left upper lung-field with a primary focus probably in the thymus. Three series of x-ray deep therapy were administered. In the first, a total of 7,810 r distributed over five areas was applied in six weeks. The right lower area received only 3 × 330 r and was not irradiated again. Three months later a total of 5,600 r was given over the same areas and the last series, three months later, was the application of 3,900 r in four weeks through four fields. The case history is related in detail. At postmortem there was extensive radiation fibrosis of both lungs and a huge fibrous body in the upper mediastinum which did not contain tumor cells. It is assumed that in addition to a large enough dose, certain other factors must be considered as contributory to the development of such extensive fibrosis following irradiation.

The author mentions inflammatory processes in the lungs and a certain tendency of some persons to respond to irradiation with connective tissue proliferation. Caution seems indicated in establishing the dosage when irradiating the thorax.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Injury of the Lung, with Fatal Outcome. E. Schairer and E. Krombach. Strahlentherapie, **64,** 267, 1939.

In this paper the authors give in great detail their histologic findings of the case reported by Bauer in the same journal, page 249. They distinguish two stages of roentgen injury, first, the principal reaction with an acute inflammatory process, and the stage of repair accompanied by proliferation of the connective tissue. Because of the use of protracted fractional dose methods these two stages cannot always be sharply separated in the human. The pathogenesis of the changes in the lung is described, and an explanation of the various observations given, using the so-called blood vessel theory of Ricker. The authors propose the term "chronic pneumonia due to roentgen rays" for this pathologic anatomical picture.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Injury and Blood Picture. K. Marder-steig. Strahlentherapie, **64,** 311, 1939.

The author discusses the changes in the blood picture which occur following prolonged exposure to roentgen rays, especially in professional workers. He states that at this time such injuries are extremely rare because of the protective measures which have been adopted in all modern x-ray departments. The amount of scattered radiation to which the radiologist and the technicians are exposed while observing the safety rules, is apparently too small to cause blood injury. The deviations the author found, in studying various groups, seem to remain within physiologic fluctuations. He recommends blood examination before starting work in an x-ray department and then at intervals of six months. Blood studies should include determination of the reticulocytes because they give us a definite indication as to the function of the red bone marrow. Recent studies have also shown that the physiologic fluctuations in leukocytes do not lie between 6,000 and 8,000, but between 3,500 and 9,000, while the lymphocytes varied from 20 to 45 per cent. This should be considered before diagnosing an early radiation injury manifesting itself in a slight leukopenia or lymphocytosis.

ERNST A. POHLE, M.D., Ph.D.

Injury of the Intestines Due to Roentgen Rays. H. Buhtz. Strahlentherapie, **64,** 291, 1939.

During the years from 1933 to 1937, three cases of injury of the intestines following x-ray deep therapy came to postmortem examination at the Pathological Institute in the University of Frankfurt on Main. The histories of all three are related in detail. Ul-

ceration was present macroscopically; the histologic studies showed necrosis of the intestinal wall of varying degree, including fibrosis of the submucosa, hyperplasia of the muscular layer, injury of the serous layer, infiltrations, and also vessel changes, beginning with slight endarteritis and leading, in some instances, to endophlebitis obliterans. It is important to note that these histologic changes were found in the adjacent areas which did not show any macroscopic injuries. One case was treated for a carcinoma of the prostate, one over the left ilium, and the third for carcinoma of the prostate and bladder. Since the topographic localization of the necrotic lesions was, in each instance, within the beam of radiation, the diagnosis of roentgen injury seems to be definitely established.

ERNST A. POHLE, M.D., Ph.D.

SARCOMA

Ewing's Sarcoma. Charles F. Geschickter and I. H. Maseritz. Jour. Bone and Joint Surg., **21,** 26–39, January, 1939.

This is a study of 135 cases of Ewing's sarcoma to determine the diagnostic features of the disease. The roentgenographic appearance was sufficient to diagnose 70 per cent of the cases, but microscopic examination is the final test.

The difference between Ewing's sarcoma and sclerosing osteogenic sarcoma is not too difficult to determine because the latter shows patchy sclerosis and irregular ossification of the periosteal zone.

Osteolytic osteogenic sarcoma is usually differentiated readily by x-ray examination, except in those cases in which the destructive lesion is surrounded by periosteal reaction and in such instances biopsy is needed.

Chondrosarcoma can simulate Ewing's sarcoma very closely and is differentiated only by biopsy.

Metastatic lesions, multiple myeloma, Christian's disease, and leukemias are easily differentiated from Ewing's sarcoma, but neuroblastoma is not so readily differentiated even on microscopic study. Subacute and chronic osteomyelitis can be very confusing. Osteomyelitis resembles Ewing's sarcoma in age incidence, incidence of trauma, temperature, and leukocytosis. Similarity in roentgenographic appearance results from the fact that Ewing's sarcoma is invasive, along the shaft of the bone, invading the medullary cavity and destroying bone spicules. New bone is laid down both subperiosteally and subendosteally. The onion-peel formation in Ewing's tumor is due to new-bone formation separated by tumor tissue.

The transverse striations sometimes seen in Ewing's tumor are finer and more hair-like than those seen in sclerosing osteogenic sarcoma. This osteogenic sarcoma is usually confined to the distal end of the bone shaft, while Ewing's tumor usually extends from one-third to one-half the length of the shaft and thus resembles osteomyelitis.

Endothelial myeloma is a specific class of bone sarcoma, but the microscopic types are still confusing. Patches of endothelial cells replace normal tissue, and the individual cells are closely packed or separated by small open spaces, resembling reticulum-cell sarcoma of lymph nodes. There is a tendency for the cells to proliferate about blood vessels in marrow spaces.

The commonest type of cell found is the small or moderately large round or oval cell with little cytoplasm. The reticulum cell is second in frequency, the spindle type third, while the lymphocyte and myelocyte types are rare.

Biopsy is always in order. Surgery is advised with removal of the entire shaft, or, in weight-bearing bones, amputation of the extremity.

JOHN B. MCANENY, M.D.

Lymphosarcoma of the Small Intestine. Edmundo Vasconcellos and José Finocchiaro. Ann. Paulist. de Med. e Cir., **36,** 459–476, November, 1938.

The essayists, after reviewing the literature to demonstrate the rarity of the lesion, report a case on a two-year-old girl. The tumor was in the jejunum, with metastasis to both ovaries.

The symptomatology of this condition depends on the location of the growth, its complications, and general constitutional changes brought about by these complications.

Toxic symptoms appear early and progress rapidly, causing death within six months from the time of their incipiency. Local symptoms are still more variable, depending principally on the site of the tumor. When it is located in the duodenum, or high on the jejunum, the lesion presents a syndrome similar to stenotic pyloric ulcers; while, when located in the distal ileal loop, diarrhea alternating with partial obstruction is the more common symptom. Often a long period of latency is enjoyed, during which the symptoms and signs become fixed, such as an abdominal tumor, hard, sometimes movable, others fixed, depending upon whether or not it has invaded the retroperitoneal space. Pain is then complained of because of mesenteric infiltration by the tumor, or partial intermittent intestinal obstruction. Complete obstruction is relatively rare because of the fluidity of the feces in this portion of the intestines.

Ullmann and Abeshouse, in 126 cases, found 15 cases of acute intestinal obstruction. Compression by the tumor on most of the neighboring organs may be the cause of edema, icterium, or urine retention.

ANTONIO MAYORAL, M.D.

THE SHOULDER

The Technic of Radiological Examination of the Shoulder Joint. Ireneusz Kukliński. Polski Przegl. Radiol., **13,** 87–95, 1938.

After discussing the technical difficulties incumbent to the problem of obtaining radiographs of the shoulder joint in two different planes, the author recommends a technic by which the rays enter from the axilla and the plate is placed on top of the shoulder, while the upper

arm is elevated and abducted. It is obvious that the procedure demands that the radiographic equipment be absolutely shock-proof.

ERNST A. SCHMIDT, M.D.

Osteosarcoma of the Shoulder Revealed by a Pulmonary Metastasis. J. Audan. Bull. et mém. Soc. de radiol. méd. de France, **26,** 481, July, 1938.

A chest film, of a patient who was suffering from an apparent exacerbation of an established osteo-arthritis, revealed multiple metastatic nodules in the lung. Subsequent films of the shoulder demonstrated an advanced osteosarcoma of the head of the humerus. Changes in the symptoms even in known cases of osteo-arthritis should justify further roentgen studies of the involved joints.

S. R. BEATTY, M.D.

SILICOSIS

Silicosis and Silico-tuberculosis. Henry K. Taylor and Hyman Alexander. Jour. Am. Med. Assn., **111,** 400–408, July 30, 1938.

Silicosis may be defined as a pathologic condition of the lungs due to an inhalation of silicon dioxide. It can be produced experimentally in animals. It is generally agreed by the majority of authors, wherever extensive investigations on silicosis have been carried on, that the special form of fibrosis characteristic of silicosis is produced only by uncombined silicon dioxide. Jones (1933) found a high incidence of silicosis wherever miners encountered rock rich in sericite (also known as white mica and the hydrated silicate of aluminum and magnesium) and in mining localities where a rock contained a high percentage of silica but had no sericite in it no silicosis was found. Experiments by Lemon and Higgins and other investigators failed to verify the observations made by Jones. At the present time, workers in this country feel convinced that silicosis is a specific reaction to silicon dioxide.

In considering any dust, the greater the percentage of free silica and the greater the concentration of small particles per given volume of air, the less will be the duration of exposure before silicosis makes its appearance.

Investigators in all parts of the world have continually stressed the fact that the incidence of tuberculosis among persons with silicosis is considerably higher than among the rest of the population. This concept is almost universally accepted. It is also generally agreed that a large percentage of persons with silicosis die from a superimposed tuberculous disease. According to Gardner (1934), at least 75 per cent of those in whom silicosis develops die of tuberculosis, which may make its appearance at any stage of the disease. In many reported series, the diagnosis of silico-tuberculosis was made from the history, physical manifestations, and roentgen examinations. Gardner (1934) believes that tuberculosis superimposed on silicosis is of the proliferative type. In his experience with silico-tuberculosis, there is little exudation and caseation. Tubercle bacilli may not be demonstrated in the sputum for many years. He claims that cavities, if they do occur, are late manifestations.

The roentgen diagnosis of a fibrotic type of tuberculosis superimposed on a silicotic lung, which is in itself a fibrosed lung, appears to Taylor and Alexander to be exceedingly difficult and almost impossible to make with any degree of certainty. It must be borne in mind that silicosis is a progressive disease and that the fibrotic changes in the lung spread slowly and eventually involve large areas, areas in which one ordinarily expects tuberculous changes to take place. It is, therefore, possible that statistical studies on silico-tuberculosis which are based on clinical and roentgen studies alone are not very accurate. In studied series of cases in which men doing an extensive amount of work on chests felt that the diagnosis of silico-tuberculosis was justifiable, only 41.8 per cent of those admitted with the diagnosis of silico-tuberculosis were accepted as such. Their own experience suggested that the incidence of tuberculosis and silicosis is considerably below 60 per cent in a non-selected group at large.

CHARLES G. SUTHERLAND, M.D.

THE SINUSES

Osteomas of Paranasal Sinuses and the Mastoid Process: Report of Cases. Bert E. Hempstead. Jour. Am. Med. Assn., **111,** 1273–1275, Oct. 1, 1938.

Osteomas that arise in the paranasal sinuses are not common. Occasionally they are discovered in routine roentgenologic examination of the sinuses. They are not diagnosed clinically or even suspected of existing until either evidence of intracranial complications or external deformities appear. The etiology of these bony growths has never been determined. Osteomas develop frequently at the site of the fronto-ethmoidal suture. The ethmoid bone is developed from cartilage and the frontal bone is developed from membrane. Arnold advanced the hypothesis that cartilaginous rests were present and that these enlarge and develop later into bone. He pointed out that where tissues of different embryologic origin come together there is a predisposition to growth of tumors. Against this hypothesis is the fact that no cartilaginous débris has ever been found in these tumors and that tumors appear at sites where this difference in embryologic derivation does not exist, such as at the recessus nasalis of the frontal bone, at the maxillary antrum, and at the tip of the mastoid bone.

Virchow believed that the site of origin of such tumors was the diploe of the frontal bone. Scarcely would this explain occurrence of the growth in other places. Infection has been suggested as a possible cause, but many times the tumor is present without any evidence of infection, either macroscopic or microscopic. A history of trauma is obtained many times, the blow, however, usually is so insignificant that probably it is

not the etiologic factor. It has been suggested that such tumors originate from the periosteum.

These tumors may be hard and eburnated in structure, they may be spongy, or they may consist of a mixture of these two types of structure. Growth is very slow. Usually the tumor is attached by a pedicle of cancellous structure. This growth can prevent drainage of the sinus and thus give rise to a pyocele or a mucocele, which may be the direct cause of deformity.

The patient who has an osteoma usually presents himself because of pain, external deformity, or symptoms due to an intracranial complication. Roentgenologic examination is of the greatest service in indicating the exact site of the tumor and whether or not it has invaded the cranial cavity. This point must be determined carefully by stereoscopic examination, since the surgical approach depends much on this.

Two cases are reported in this article, one a large osteoma in the ethmoid region and the other an osteoma situated on the mastoid process.

CHARLES G. SUTHERLAND, M.D.

SKIN DISEASES

The Value of Radiation Therapy in Skin Carcinoma. Archie Fine and Samuel Brown. Jour. Med., **20,** 70–75, April, 1939.

Beginning with a sketch of the various factors governing the quality of radiation and statement of the unit of quantity of radiation, the authors define the various types of skin cancers with their characteristics.

The choice of treatment depends upon the size of the lesion, its location, and thickness. With a small lesion, low voltage is used, administering three erythema doses of unfiltered radiation at each of three sittings. In a thicker lesion, the same amount of radiation is given but the two later treatments are given through 1 mm. aluminum. A previously treated lesion, or one that involves cartilage or deep structures, is treated by high voltage and heavily filtered radiation, in small doses over a period of from 20 to 41 days until a total of from 6,000 to 8,000 r has been given.

No definite information of radium treatment of skin cancers is given, but the authors do caution against promiscuous use of radium by those unfamiliar with its behavior. Several excellent case reports are given.

JOHN B. MCANENY, M.D.

Epidermal Tumors of the Skin. I. G. Williams. British Jour. Radiol., **11,** 641–648, October, 1938.

The author reviews 214 cases, involving 230 sites, as some of the tumors were multiple. A majority (73.4 per cent) were on the head and neck, 28 per cent were on the face and cheek, and 19 per cent on the ear. Squamous-cell carcinoma is more common on the lower lid of the eye than on the upper, while the basal-cell type is nine times more common than the squamous-cell type on the upper lid. The evidence in many of these cases supports the belief that these tumors infiltrate along the lines of fusion during embryonal development.

The largest group (150 cases) were squamous-cell lesions preceded by keratotic changes. The lesions, which are frequently multiple, occur on the exposed parts of persons subjected to changing atmospheric conditions. The local lesions are highly radiosensitive. Glandular metastasis is slow to occur, but is highly resistant to radiation. Large tumors are treated with 200 kv.p. or teleradium therapy, aiming to give 6,000 r in from 7 to 17 days. A table is included showing results of therapy in the keratotic cases between 1925 and 1936. The best results are obtained with radiotherapy alone, or radiotherapy combined with surgery.

One case of squamous carcinoma of the cervix, thought to be due to long-continued ingestion of arsenic, and nine cases of tar and soot carcinoma are reported.

Thirty cases of carcinoma supervening on chronic lupus are reported. Epitheliomas appear sooner in a greater proportion of cases of lupus treated by radiation therapy.

Five cases of x-ray carcinoma are reported. These responded well to 6,000 r given in 14 days.

Four cases of squamous carcinoma arising on scar tissue are reported, and six cases of squamous carcinoma on chronic ulceration. The incidence of carcinoma elsewhere is not common. Seven out of 175 patients died of malignant disease elsewhere in the body, an incidence of 4 per cence.

S. J. HAWLEY, M.D.

Disease of Besnier-Boeck-Schaumann. Leon Babalian. New England Jour. Med., **220,** 143–145, Jan. 26, 1939.

The development of this disease picture is outlined through the years by the work of Besnier, Boeck, and Schaumann, as combined by Pautrier.

There are two types of cutaneous lesions. One is a nodal type with cherry-stone sized nodes that are infiltrated, yellow-red, or violaceous elevations of variable number. These are the so-called nodular Boeck's sarcoids. The other type is marked by patches that are smooth, blue-red, soft and smooth, and known as Boeck's diffuse, infiltrating sarcoid. Under glass pressure the translucent miliary grains resemble lupus vulgaris.

The ocular lesions consist in conjunctivitis and sometimes iritis. Some cases of granular conjunctivitis of Parinaud belong to this disease.

Lymphatic lesions must be searched for. The tonsils, lymph glands of the neck, axilla, groins, and tracheobronchial region may be enlarged.

In the lungs numerous miliary lesions in the upper two-thirds are found. These granulations are dense, with fuzzy contours and may become confluent. Physical findings in the chest are negative and fever is absent.

Bone lesions are found only on x-ray examination and consist in well-circumscribed cystic cavities.

Visceral lesions rarely produce symptoms and are found only at autopsy. Blood findings present only a monocytosis.

The diagnosis is difficult. X-ray examination is essential. A negative tuberculin test is most helpful. Guinea pig inoculation with material from the lesions is never positive for tuberculosis. Diagnosis lies in tissue sections which show infiltration consisting of nodules of epithelioid cells, surrounded by scattered lymphocytes, but never in a dense zone. Giant cells are exceptional and necrotic areas are never found.

The etiology is unknown but is definitely known not to be tuberculosis. No treatment is specific

J. B. McAneny, M.D.

THE SKULL

A Position for Radiography of the Fourth Ventricle. T. Garratt Hardman. British Jour. Radiol., **11,** 726–735, November, 1938.

The fourth ventricle is visible only when the aqueduct is dilated and the third ventricle is larger than normal. In the normal case, the failure of the fourth ventricle to fill may be due to the small size of the aqueduct or the rapid diffusion of air into the cisterna. Thorotrast was tried, but while it is satisfactory from a radiographic standpoint, it produced shock.

The best results in visualizing the fourth ventricle are produced in lateral radiographs of the skull with the patient lying prone, the skull in the usual nose-forehead position with the head on a small pillow, so that the base of the skull makes an angle of 90° with the surface of the table.

In hydrocephalus, the location of the site of obstruction is important. On this lateral film, the following interpretations may be made: (1) well-filled aqueduct and fourth ventricle indicates an obstruction of the foramina of Magendie and Luschka, which may be due to arachnoiditis or congenital deformity of the cerebellum; (2) filling defects on the shadow of the fourth ventricle may be due to tumors of the floor or roof, or to extrinsic tumors; (3) large tumors may cause forward displacement of aqueduct; supratentorial kink of the aqueduct is believed to indicate an infra-tentorial tumor; (4) a block of the aqueduct may be due to an inflammatory condition; the absence of displacement differentiates it from tumor; (5) a block occurring at the upper end of the aqueduct may be difficult to interpret unless the posterior portion of the third ventricle is visualized also. Five cases are cited, with illustrations showing the application of these points.

S. J. Hawley, M.D.

THE SPINAL CORD

Treatment of Fracture-dislocation of the Spine Associated with Cord Injury. Claude C. Coleman and John M. Meredith. Jour. Am. Med. Assn., **111,** 2168–2172, Dec. 10, 1938.

Laminectomy for injury to the spinal cord due to fracture-dislocation is indicated only for the relief of localized compression of the cord which has not been destroyed at the level of injury.

Compression of the cord can be determined accurately only by the Queckenstedt test. If the test is negative, there is no indication for operation in closed injuries, regardless of the severity of the lesion. If the test is positive, laminectomy is indicated only if one believes that the cord possesses some capacity for recovery.

Lesions of the cord producing immediate and complete physiologic interruption have, in the experience of the authors, shown no indication of recovery regardless of the treatment employed and operation in those cases has come to be regarded as a futile procedure.

Reduction of the dislocation in the cervical region by skeletal traction, while not improving the patient's chances for restoration of cord function in complete cord lesions, is in such cases useful for the relief of root pains. It is a practical and simple substitute for laminectomy.

Severe incomplete cervical cord lesions showing compression with stationary or increasing symptoms may be treated for from 18 to 24 hours by traction. If the symptoms are unchanged and pressure persists after this time, laminectomy under local anesthesia is indicated while traction is being maintained.

Charles G. Sutherland, M.D.

Review of Neuropsychiatry for 1938. Stanley Cobb. Arch. Int. Med., **62,** 883–899, November, 1938.

Of radiological interest is the discussion of the sciatica syndrome in which it has been noted that a certain number of cases are due to a protrusion of the intervertebral disc in the lumbar region, causing pressure on the contents of the spinal canal. This can at times be demonstrated on the roentgenogram as a narrowing of the intervertebral disc. Definite roentgen diagnosis can be made by the injection of iodized poppyseed oil into the lumbar sac of the spinal canal. Treatment is then surgical removal of the mass protruding into the canal.

C. W. Reavis, M.D.

THE SPINE

A Radiologic Study of Dislocations of the Normal and Pathologic Cervical Spine. Adriana Ascarelli. Arch. di Radiol., **14,** 249–270, 1938.

The author describes and illustrates eight cases of dislocation of the cervical spine. In all of his cases fracture was present. He points out that exposures made in several projections may be necessary to demonstrate the dislocation.

E. T. Leddy, M.D.

Protruded Intervertebral Disks: Report of 100 Cases in which Operation was Performed. J. Grafton Love and Maurice N. Walsh. Jour. Am. Med. Assn., **111,** 396–400, July 30, 1938.

This report of 100 cases of protrusion of one or more

intervertebral disks in which the patients were operated on at the Mayo Clinic, summarizes particularly the neurologic findings. The total number of intervertebral disk protrusions found in these 100 cases was 113. In 88 cases there was protrusion of only a single disk; in six of these the protrusion was in the cervical region, in six it was in the thoracic region, and in 76 it was in the lumbar region. Multiple occurrences were found in the lumbar region in 11 cases and in the eleventh thoracic interspace in one case. There were 39 (34.5 per cent) protrusions of the fourth lumbar intervertebral disk, 47 (41.6 per cent) of the total of 113 protruded disks occurred in the fifth lumbar intervertebral space.

It was of interest to note that these protrusions tended to occur predominantly in the region of greatest convexity or concavity of the vertebral column, regions in which the greatest mechanical stress is placed on the vertebral column by heavy lifting or pushing.

In only 32 per cent of the cases was a history of pain or other symptoms beginning immediately after a certain injury elicited. In 29 per cent there was no history of injury that the patient could recall. The average duration of symptoms before operation in this 100 cases was four years; the shortest duration was one month, the longest 32 years. Nocturnal pain was present in 29 per cent and aggravation of pain on coughing or sneezing occurred in 36 per cent of the cases. Intermittence of symptoms was a prominent feature in this series (86.3 per cent in the case of lumbar protrusions); in many cases, between recurrences of symptoms, the patient felt quite well. It is probable that the protruded nucleus pulposus in many instances returns into the intervertebral space, only to be extruded again by additional trauma. It is quite possible that the nerve root may be decompressed and the symptoms temporarily relieved by sliding the root away from between the protruded disk and the pedicle of the vertebra. This, however, has not been verified.

The estimation of the total protein of the cerebrospinal fluid was the only laboratory determination of value in the diagnosis of protruded disks in the lumbar region. The finding of a value for total protein in the spinal fluid higher than 40 mg. per 100 c.c. is of value in the diagnosis of protruded disk, but the finding of a value less than 40 mg. does not exclude the possibility of protruded disk.

The diagnosis is confirmed and the protruded disk identified by fluoroscopic examination of the spinal canal after the subarachnoid injection of iodized oil through a lumbar puncture needle. Five c.c. of iodized oil is injected between the spinous processes of the third and fourth lumbar vertebræ. Care should be exercised to avoid extradural injection, and rarely is cisternal injection justified. If, on examination of the movements of the opaque oil in the spinal canal, a persistent defect characteristic of protruded disk is observed, and if a lesion located at that level could account for the patient's pain, surgical removal of the protruded portion of the disk would be indicated.

CHARLES G. SUTHERLAND, M.D.

Rupture of the Nucleus Pulposus: Anatomical Study. Martin Batts, Jr. Jour. Bone and Joint Surg., **21,** 121–126, January, 1939.

In an examination of the lumbar spines of 50 cadavers, Botts has found that the nucleus pulposus was ruptured posteriorly in 16 per cent of the cases, with indications that symptoms must have been present in about 4 per cent.

Some specimens showed the ruptured nucleus pulposus projecting backward so that the nerve could easily have been compressed against the ligamentum flavum, which is usually hypertrophied in this area.

Illustrative specimens are reproduced and are quite instructive.

JOHN B. MCANENY, M.D.

THE STOMACH

Extensive Lacunar Defect of a Gastric Tumor Not Perceptible to the Surgeon. H. Duclos. Bull. et mém. Soc. radiol. méd. de France, **26,** 11–13, January, 1938.

The author presents an instance in which a large papillomatous tumor of the greater curvature of the antrum of the stomach, demonstrable roentgenologically, was not perceptible to palpation at laparotomy. Section of the stomach confirmed the roentgenologic diagnosis.

S. R. BEATTY, M.D.

The Dyspepsia of Decubitus: Painful Syndrome of Cascade Stomach. J. Barbier, J. Bourret, and G. Bertrand. Jour. de méd. de Lyon, **19,** 495–502, Aug. 20, 1938.

Frequently one finds that individuals with stomachs of the cascade type suffer from a syndrome of dyspepsia which is aggravated when they lie down after meals. A sensation of epigastric fullness and weight may be followed by nausea and vomiting. This is probably due to a reflux of partially digested food into the cardia. Fermentation here, or the accumulation of gastric secretion in the unfilled lower portions, probably causes the sensation of fullness and distress. The treatment consists essentially of emptying the pocket by postural exercises or avoidance of the post-prandial rest.

Pathologic causes for the cascade form of the stomach must be eliminated by careful examination.

S. R. BEATTY, M.D.

Hemorrhagic Cancerous Ulcer of the Stomach. René A. Gutmann, Jean Charrier, and I. Bertrand. Bull. et mém. Soc. de radiol. méd. de France, **26,** 142, 143, March, 1938.

That clinical studies alone are of little value in the diagnosis of gastric cancer, and that slow increase in roentgenologic signs even in the absence of clinical signs and symptoms is characteristic of carcinoma of the stomach, are facts well demonstrated by a case of the authors. The symptoms consisted only of two gross hemorrhages. The roentgenologic studies (13

months) demonstrated the slow development of an apparently benign type of ulcer into a typical carcinoma.

S. R. BEATTY, M.D.

A Case of Carcinoma of the Stomach Presenting Some Unusual Relief Markings. T. D. Overend. British Jour. Radiol., **11,** 739, 740, November, 1938.

A brief case history is given of a patient with a large ulceration on the lesser curvature. Distal to this ulcer, the rugæ of the stomach ran transversely. The rugæ proximal to the ulcer were normal. The diagnosis of carcinoma was confirmed at operation. There was no extension into the distal portion of the stomach. The transverse mucosal folds appeared to be produced by an edema, without inflammatory reaction, probably the result of obstruction to lymphatic flow in the submucosa.

S. J. HAWLEY, M.D.

Gastric Hemorrhage. Damon B. Pfeiffer. Jour. Am. Med. Assn., **111,** 2198–2201, Dec. 10, 1938.

That bleeding ulcers give rise to the majority of gastric hemorrhages (68 to 89 per cent) and hemorrhages from the upper part of the intestinal tract is clear. Gastric carcinoma is credited with causing 1.5 to 25 per cent and esophageal varices and carcinoma of the esophagus from 5.3 to 6 per cent. That the differential diagnosis between peptic ulcer, carcinoma of the stomach, gastritis, and the varices of cirrhosis or splenomegaly can be far from simple is perhaps not so well appreciated. It is important, nevertheless, to establish the diagnosis at the earliest possible moment.

The problem of treatment arises at once and, like the problem of diagnosis, it is far from simple. Early feeding, as advocated by Muelengracht, the massive drip transfusion and the aluminum hydroxide drip, all relatively recent innovations, suggest that the standard treatment of bleeding peptic ulcer based on starvation and sedation can no longer be universally accepted. Statistical studies go further and show that some patients with bleeding peptic ulcer will die from hemorrhage in spite of any form of medical treatment.

It seems fair to state that the mortality from massive hemorrhage complicating peptic ulcer, in this country at least, is 5 per cent or more with medical treatment. The mortality from massive hemorrhage complicating duodenal ulcer is definitely higher. The only hope for certain patients lies in early operation.

The attitude of the surgeon toward this complex and interesting problem should be characterized by a desire for close co-operation with the medical man in every case of hemorrhage. Patients should be hospitalized. All efforts should be made to arrive at a prompt and accurate diagnosis. In each case a decision as to whether the patient should be treated medically or whether surgical intervention alone can save him should be made within Finsterer's time limit of from 24 to 48 hours from the onset of bleeding. The few patients who can be saved only by operation must be operated on early if they are to have every chance.

In making decisions of this nature, one can be guided somewhat by a few established facts. The incidence and the mortality of hemorrhage from ulcer is greater for men than for women; and they rise with age and with the presence of arteriosclerosis and hypertension. Hemorrhage from duodenal ulcer carries a higher mortality than hemorrhage from gastric ulcer. Hemorrhage from chronic ulcer is more likely to be fatal than hemorrhage from acute ulcer. Mortality rises rapidly with a second or third massive hemorrhage closely following initial bleeding. Forty per cent of the patients who have bled once will not be relieved of ulcer symptoms by medical treatment and 80 per cent of the patients who have bled two or more times will not be relieved of ulcer symptoms by medical treatment. The principal factor which influences mortality is the time interval between the onset of hemorrhage and operation. At operation for bleeding ulcer, the primary consideration is hemostasis. After operation, continued medical care should be the rule, and in selected cases more extensive surgical procedure should be considered.

CHARLES G. SUTHERLAND, M.D.

Study of a Case of Villous Tumor of the Stomach. André Cain and Roger Cattan. Arch. d. mal. de l'app. digestif, **27,** 1009–1024, December, 1937.

The authors give in some detail the clinical, radiologic, and microscopic findings of a case of villous tumor of the pylorus, of a type similar to the villous tumors of the rectum.

S. R. BEATTY, M.D.

Clinic on Lymphogranulomatosis of the Stomach. R. Bukowski. München. med. Wchnschr., **85,** 2021, 2022, Dec. 30, 1938.

The author reports three cases of gastric lymphogranulomatosis. He believes that with the present clinical and radiological methods it is impossible to make this diagnosis certainly in cases of isolated gastric lymphogranulomatosis, except by pathological study.

LEWIS G. JACOBS, M.D.

TUBERCULOSIS (GENERAL)

The Influence of Age-determined Factors on the Development of Tuberculosis. Arnold Rice Rich. Minnesota Med., **21,** 745–763, November, 1938.

The author presents an exhaustive review of the present-day knowledge of immunity as applied to tuberculosis. The material covered is too great in scope to permit of more than the most inadequate treatment in any abstract. The question dealt with throughout the paper is the changing susceptibility to tuberculosis manifested at various ages.

First, there is the period under one year, when the mortality rate is the highest of all. Rich questions the figures of Gottstein, who believes that tuberculosis under one year results in an 80 per cent mortality, believing this figure too high.

The absolute value of the tuberculin test is questioned. Seventeen per cent of persons over four years of age who showed *negative* tuberculin reactions were found to have calcified lesions on x-ray examination. The author then says: "Since it is well known that the x-ray reveals the primary lesion in only a small percentage of all who do react to tuberculin and are, therefore, known to be infected, it is clear that the total number of infected persons among those who fail to react must be much larger than the number discovered by x-ray in the above-mentioned studies."

The matter of antibody formation is probably the essential factor in the lower resistance to infection under one year of age.

The author says further: "In the human being. . . . not only is a negative tuberculin test no proof that the individual has never been infected, but it is also no proof that acquired resistance is lacking."

Studies based upon wide surveys reveal:

1. That tuberculosis is most fatal during the first year of life.
2. That it is much less dangerous but still markedly so during the succeeding several years.
3. That the period between five years and puberty is a strikingly "safe" period, during which the mortality from the disease decreases in spite of the fact that the incidence of infection increases.
4. That following the age of puberty there occurs a sharp increase in the death hazard among those infected.
5. That the increase in tuberculosis mortality hazard continues steadily into adult life, reaching a peak in the middle twenties.
6. That in old age there occurs a second peak in the mortality hazard.

The factors having a possible relationship to the above clinical facts are discussed in detail in this paper.

PERCY J. DELANO, M.D.

The Measurement of the Dose on Radium Applicators. E. Hasché and J. Bolze. Strahlentherapie, **63**, 701, 1938.

Photographic methods of determining radium doses in r have been described by Holthusen, who uses a cube of wood, and Friedrich, who uses a cube of water. The authors experimented with air as the absorbing material. In order to allow for any difference in the results due to the absorbing medium, they insert a constant k in the relation 1 mg.-hr./cm. = k×8. 0 r. The method of preparing the calibration films and the results of their comparisons between photographic and electrometric determinations are given. It appeared that the method is practical and has the advantage of making possible the measuring of soft and hard gamma rays as well as beta rays in r.

ERNST A. POHLE, M.D., Ph.D.

TUMORS (DIAGNOSIS)

Adamantinoma of the Tibia. R. Glyn Thomas. British Jour. Surg., **26**, 547–554, January, 1939.

This an interesting case report of a rare condition, few instances of which have been recorded in the literature. The patient was a girl, aged 19, who gave a history of a painless swelling below the right knee since the age of 12 years. Examination revealed a cystic tender mass at the upper end of the tibia and a smaller one at the lower end. The first roentgenograms of the leg showed cystic changes at the upper and lower ends of the tibia suggesting giant-cell tumor, possibly undergoing malignant changes. Examination of the blood showed high serum calcium with a negative calcium balance. The plasma phosphatase was slightly higher than normal. Histological examination of bone curettings was reported as adamantinoma of the tibia. Operation was performed several weeks later, consisting of thorough curettage of the involved bone followed by insertion of two bone grafts taken from the opposite tibia. Four months later, roentgenograms showed the bone grafts *in situ* but little new bone formation. After several months, the patient's general condition became worse and there was now evidence of invasion of the soft tissues of the leg, and amputation above the knee joint was performed. The tumor was found to extend along the entire shaft of the tibia and was both cystic and solid in parts.

Radiation has little or no effect on these tumors and was not attempted in this case. Curettage of tumor and bone grafting may be tried but amputation is the final procedure to insure recovery.

MAX CLIMAN, M.D.

Intercranial Tumors in Children. Percival Bailey and Marie-Louise Ectors. Bruxelles méd., **18**, 1253–1265, July 24, 1938.

Intercranial tumors are frequent in children, as are tumors of the nervous tissues throughout the body. The syndrome of increased intercranial pressure is modified by the elasticity of the skull. Sub-tentorial tumors predominate. Astrocytomas and medulloblastomas are most frequent. The treatment is chiefly surgical. (This is an excellent, brief discussion of the subject.)

S. R. BEATTY, M.D.

Brain Tumors in Children. Paul C. Bucy. Jour. Iowa State Med. Soc., **29**, 47–53, February, 1939.

Tumors of the brain, in childhood, are usually of a different type than those occurring at later age periods. The most common tumors at this age are cerebellar astrocytomas, malignant tumors (medulloblastomas and meningeal sarcomas) of the posterior midline of the cerebellum, ependymomas of the fourth ventricle, gliomas (usually spongioblastomas) of the pons, and a variety of tumors in and about the third ventricle (craniopharyngiomas, spongioblastomas and other gliomas of the optic chiasm and hypothalamus, pineal tumors, etc.). While benign meningiomas, pituitary adenomas, and cerebral gliomas may occur, they are distinctly rare.

In a series of 100 cases, the frequency of these common tumors in childhood was as follows: pontine glio-

mas, 15 to 20 per cent; ependymomas of the fourth ventricle, 7 per cent; tumors in and around the third ventricle, 20 per cent, and astrocytomas of the cerebellum, 20 to 25 per cent. Of these, all but the astrocytomas present a discouraging therapeutic problem and a bad prognosis. The cerebellar astrocytomas are benign, can be removed with a low operative mortality rate, and with the almost complete certainty that if removed they will not recur. Since these tumors are largely confined to one hemisphere of the cerebellum, the signs of cerebellar dysfunction are predominantly unilateral and confined to the extremities on the same side of the body as the tumor. Although no other tumor is likely to produce this unilateral picture of cerebellar dysfunction in childhood, astrocytomas of the cerebellum do occasionally occupy the midline and reproduce the symptomatology of the malignant tumors. Therefore, every child suspected of harboring a brain tumor should be treated as though it were benign and removable until it is definitely proved to be otherwise. Only in this way may life or vision be preserved.

Because the manifestations of these tumors usually progress more slowly than do those of the malignant tumors of the cerebellum, the changes revealed by the x-rays are more pronounced. The sutures usually are separated, the sella turcica is enlarged, the clinoid processes are eroded, convolutional markings on the inner table of the skull are common, and the cerebellar fossa may be enlarged, due to bulging and thinning of the occipital region.

L. W. PAUL, M.D.

A Theory of the Action of Radiations on Biological Materials Capable of Recovery. Part I.—The Time-intensity Factor. D. E. Lea. British Jour. Radiol., **11,** 489–497, July, 1938.

In many biological reactions the effect of a given dose depends upon the intensity or the manner of fractionation. If the intensity is low, the recovery processes may keep pace with the damage done. If the intensity is high, so that the time of administration is short compared with the time required for recovery, the total dose required for a given effect will be a minimum. The curve to express the relation between dose required to produce a given effect, and the intensity will be in the nature of a rectangular hyperbola. To determine the actual shape of the curve, something of the mechanism of the action of radiation on biological material must be known.

The dissipation of energy by radiation in its passage through matter is not continuous, but occurs in discrete units. A biological effect is produced when a specific amount of energy is dissipated in a specific region. Thus you can classify biological reactions as being produced by single-unit action, two-unit actions, or *n*-unit actions. A large portion of the reactions are in the last class, and the number of unit actions is so large that no error is produced by considering the dissipation of energy as continuous. There is no difficulty in imagining recovery taking place slowly in reactions of this type. With a single-unit action, however, there can be no question of recovery from a dose insufficient to produce an effect, so they are in a different category. Reactions of the single-unit type must be independent of intensity. The production of mutations in *Drosophila* and the lethal effect on bacteria are reactions of this type.

The time-intensity factor may be considered when the number of units effecting the reaction is greater than one. Recovery when the number of units is large will presumably be continuous, but when the number of units is small it will be discontinuous. The two-unit theory supposes that a single-unit action fails to produce an effect, but a second unit, acting within a given time, will produce the effect. If the time is too long between the action of the two units, no reaction occurs. When a cell has received one unit, the recovery will be slow, but to all intents and purposes it will appear to be sudden at that point where recovery from the first unit has so far proceeded that the application of the second fails to produce the effect. Dose intensity curves for two-unit and *n*-unit conditions will be different, but similar in shape. These assumptions and curves apply to simple systems; with complex tissues the curves will show variations from the theory because rates of recovery of different elements will vary.

Curves calculated according to these suppositions, for the two-unit and continuous action theories, have been constructed and compared with experimental results. Curves for the two-unit and continuous action phases are almost identical and both agree well with the experimental results.

S. J. HAWLEY, M.D.

A Theory of the Action of Radiations on Biological Materials Capable of Recovery. Part II.—Delay in Cellular Division. D. E. Lea. British Jour. Radiol., **11,** 554–566, August, 1938.

Part I discusses the action of radiation on cells capable of repairing the damage done. This section develops the theory of the cumulative dose, which assumes that the residual effect of one or more doses distributed in any manner over a period of time may be stated as a single figure, which at that moment defines the future behavior of the cell. The work of Henshaw, Henshaw, and Francis on *Arbacia* eggs is quoted, which shows that there is a physical entity, proportional to the dose given, which is capable of persisting for some time, thus giving confirmation to the idea of a cumulative dose. This work also shows that the cumulative dose decays exponentially, according to the formula $e^{-t/\tau}$ (t equals time and τ, tau, a factor depending on the tissue). Curves can be constructed from this formula which agree well with experimental values.

This formula may be applied to tissue cultures, whereby the number of cells undergoing mitosis at various times after irradiation may be predicted.

The agreement between experiment and theory is such that there can be little doubt that the theory is correct in general.

S. J. HAWLEY, M.D.

The Hyperostoses in Relation with the Meningiomas. G. F. Rowbotham. British Jour. Surg., **26,** 593–623, January, 1939.

Osseous changes overlying meningiomas are recognizable radiologically. These architectural alterations are more frequently produced by enlargement of the vascular pattern of a larger or smaller area of the skull than by actual neoplastic invasion. In a series of 100 meningiomas, a hyperostosis was discovered on 23 occasions. The bones of the anterior half of the skull were affected in the large majority of cases; in fact, the occipital bone was involved in only one instance. The duration of the symptoms varied from one to 20 years, with the majority between three and five years.

The vascularity of these tumors varies greatly. The arterial supply to the neoplasm is largely from the dura mater. There are important communications between the dural veins and those of the diploe, not only in the meningeal grooves but also in the many pits seen in the inner table near the middle line over the lacunæ. The diploic channels become dilated, and it is this change which gives the radiographic picture so characteristic of the meningiomas.

Clinically, the hyperostoses were of three types: (1) obvious swelling of the skull which could be easily seen or palpated; (2) an enostosis, or mound of bone on the inner table, demonstrated only by x-ray examination, and (3) a deformity of the orbit with an accompanying exophthalmos.

1. *Thickening of the Vault.*—The most typical form shows as a diffuse mass standing an inch or more above the surrounding bone. It is differentiated from osteoma by the spiculated shadow in the roentgenogram.

2. *The Enostoses.*—Parasagittal enostoses are frequently seen which are of no pathological significance. In the presence of positive clinical signs, the enostosis is a valuable sign in determining the pathological nature of the neoplasm, for it is specific with meningiomas. Hyperostosis frontalis interna has a clearly demarcated border and is not associated with abnormal vascular markings. This well-known radiologic entity should cause no difficulty in differential diagnosis.

3. *Displacement of the Eyeball.*—Unilateral exophthalmos may be produced by various neoplasms and inflammations. The diagnosis of an underlying meningioma depends on presence of fullness in the temporal fossa, thickening of the sphenoid wings demonstrable by x-ray examination, and an increase of the proteins in the cerebrospinal fluid. Six cases in this series had exophthalmos.

Pathology.—Hyperostosis, diffuse or nodal, seems to be peculiar to meningiomas, for no other type of intracranial lesion has given rise to it. The diffuse hyperostosis of the vault is an irregular fusiform thickening consisting of both exostosis and enostosis. Close to the tables, bone is laid down in parallel trabeculæ radiating inward and outward with the exostosis covered by hazy irregular bone. The inner surface of the bone is spiculated or eroded where the meningiomatous mass is attached to the skull. Hyperostosis of the base of the skull is uncommon and usually associated with the olfactory groove or sphenoidal wing meningiomas. The author shows one case in which a basal hyperostosis has thickened the orbital walls, deforming the orbital cavity and narrowing the sphenoidal fissure. The osteoclastic type in which the tumor destroys the overlying bone is rare. Radiographically, the bone has disappeared and there is a defect with a slightly irregular edge suggesting metastatic carcinoma. Tangential views showed the bone to be expanded from within, and there was a very thin shell of external table covering it, though this may be incomplete. There were four examples of this type in the series. One of the cases is illustrated with a radiograph showing a cyst-like dilatation of the frontal bone. There were seven nodal enostoses, six demonstrable by x-ray examination and verified at operation and one at postmortem. All of these seven cases overlaid meningiomas of the massive type. The roentgenograms showed new bony trabeculæ placed in right-angled spiculations projecting from the inner table in one case and in another the trabeculæ had an irregular honeycomb appearance. Between these two extremes of bony changes, there are many varieties of internal structure.

The author believes that any type of meningioma, regardless of pathological difference, may cause a reaction in the bone overlying the tumor. A large percentage of the meningiomas in the hyperostosis group are of the psammoma type. The most frank psammomatous types may cause a large diffuse tumorous hyperostosis, a small localized enostosis, or they may fail to make the slightest impression on the bone. In all but two cases, meningioma cells were found within the bony spaces and in some instances they could be seen throughout the section. Based on histological criteria, 19 out of the 21 cases were benign and no metastatic deposits were found in a single case. Pathologically, the meningiomas in the hyperostosis group seem to possess malignant characteristics, but judged on life-history, freedom from invasion of the brain, and absence of metastatic deposits, they are essentially benign.

MAX CLIMAN, M.D.

A Large Intrathoracic Fibroma. P. Houyez. Bruxelles-méd., **18,** 1367–1369, Aug. 21, 1938.

The clinical, radiologic, and pathologic findings in a case of a large fibroma which occupied the upper half of the left chest of a 70-year-old woman are given in detail. The origin of the fibroma was not determined.

S. R. BEATTY, M.D.

TUMORS (THERAPY)

Radiotherapeutic Treatment of Certain Granulomas. R. McWhirter British Jour. Radiol., **11,** 664–666, October, 1938.

Fifteen cases of actinomycosis have been observed by the writer in the past three years. The diagnosis is established by finding the fungus in the discharge. The condition is serious, especially when the abdominal and thoracic viscera are involved. The earlier cases were treated with rays generated at 180 kv. and 0.7 mm. copper; the later cases, with 250 kv. and a Thoraeus filter. Dailyapp lications of 100 r are made, the total amount depending upon the site, extent of involvement, and age of the patient. The total dose is sometimes carried as high as 4,000 r over a long period of time. High dosage is advisable to prevent recurrence. Surgical drainage is rarely necessary. Seven out of eight of those on the face and neck healed; one which has not healed is a recent case. Three out of four abdominal cases healed; the one which did not has a small discharging sinus which is gradually healing. One out of two in the chest wall healed, and one case in the buttock healed.

Seven cases, of anal and vulvar granulomas, all due to longstanding gonorrhea, were treated. All healed, usually after a single dose of 300 r; occasionally this has been repeated at the end of a week. Other factors describing the treatment are not given. Seven cases of granuloma of unknown origin were treated; one patient recovered, two are in poor general health, and four have died. All involved the mouth, neck, or pharynx. No etiology could be discovered, but microscopic sections showed chronic inflammation and the clinical appearance suggested that the condition was caused by fungus infections.

S. J. HAWLEY, M.D.

Case Report of Wilms' Tumor in a Four-year-old Child. Henry B. Freiberg. Jour. Med., **20,** 78, 79, April, 1939.

This is the case report of a child with a Wilms' tumor of the right kidney who was given pre- and post-operative irradiation. After the initial irradiation, the tumor was smaller and more easily removed. The factors used were 200 kv., 0.5 mm. Cu filter, 15 × 15 field, three ports (front, back, and side), 140 r (in air) totalling 735 r to two ports and 700 r to the third port. The post-operative irradiation was quite similar. After eight months there were no metastases or recurrences.

JOHN B. MCANENY, M.D.

A Case of Radiosensitive Tumor of the Stomach. Schneider. Bull. et mém. Soc. de radiol. méd. de France, **26,** 523, 524, July, 1938.

A large tumor of the cardia of the stomach disappeared within three and one-half months of roentgen therapy. The clinical and roentgenologic findings in conjunction with a palpable epigastric mass made the diagnosis of gastric malignancy indisputable, although a laparotomy was not performed. The rapidity and completeness with which all evidence of involvement disappeared, made the author believe it to be a lymphosarcoma. (Technic: 250 kv., 4 ma., 50 cm. F.S.D., 1 mm. Cu filtration, 400 r every other day to a total of 4,000 r.)

S. R. BEATTY, M.D.

UROLOGY

The Study of Urology in Egypt. J. Bitschai and T. Georgiou. Jour. de radiol. et d'électrol., **22,** 368–376, August, 1938.

This is a roentgen and urologic study of the effects of bilharziasis on the urinary tract. The authors estimate that at least 66 per cent of the population of Egypt is infected with *Bilharzia* on account of the poor water supply. Following infection, calculi develop in the kidneys and prostate but more often in the bladder and ureters. Strictures and hydronephrosis often result from these massive and numerous calculi.

The authors present several interesting cases together with many fine illustrations.

J. SAGEL, M.D.

Urologic Conditions Simulating Chronic Glomerulonephritis. A. J. Scholl. Jour. Am. Med. Assn., **111,** 1421–1427, Oct. 15, 1938.

The urologist considering uremia thinks of the retention of nitrogen in the blood associated with obstruction of the vesical neck or that associated with calculous anuria. He attempts to relieve the obstruction, to subdue the infection, or to drain the offending accumulation, and he considers the prognosis as at least not unfavorable. The internist considering uremia frequently thinks in the unfavorable terms of chronic nephritis.

Pyelonephritis either alone or in association with some other lesion of the urinary tract most frequently resembles, and is most commonly confused with, chronic glomerulonephritis. In its milder forms, pyelonephritis is seen frequently by the urologist in a form in which it causes few symptoms and only slight renal damage; it persists for years and is marked by more or less frequent exacerbations. It is almost invariably bilateral, and while it occurs usually without demonstrable or evident obstruction to the outflow of urine, it also is present in some degree in most cases of obstruction of the urinary tract and is a causative factor in progressive destruction of the kidney.

Complete or partial anuria results when the two kidneys are blocked simultaneously, when the ureter to a single kidney is obstructed, or when the better of the kidneys is blocked and the other is overloaded. In contrast to the anuria associated with nephritis, the anuria associated with obstruction of the ureter is striking because of the mildness of the early symptoms. The individual patient may continue to enjoy health for several days in spite of voiding only a few centimeters of urine daily. Later preuremic symptoms, such as hiccuping, vomiting, and muscular twitching, develop. Rarely is there any difficulty in arriving at a diagnosis in cases of acute obstructive anuria.

Obstruction of that part of the urinary passage which lies below the bladder results most frequently from

prostatic hypertrophy, carcinoma, contracture of the neck of the bladder, or urethral stricture. Any of these conditions may cause retention of urine, back pressure, and renal insufficiency. It makes little difference what the cause of the obstruction may be; the effect on the upper part of the urinary tract is the same. With renal impairment, symptoms of uremia appear. If there is also present an infection of part of the urinary tract and more or less pyelonephritis, the symptoms of renal impairment and uremia progress much more rapidly. The diagnosis of most of the obstructive lesions is determined by examination of the urinary tract; if this is carried out, usually there is no particular difficulty in ruling out nephritis.

The clinical picture of impaired renal function, hypertension, and hematuria in cases of polycystic disease is very similar to that associated with chronic glomerulonephritis, and the diseases are not infrequently so diagnosed. On account of the insidious onset of polycystic renal disease and the physical accommodation to the condition, many patients are not aware of its presence until almost complete destruction of the kidney has occurred.

Hyperparathyroidism may be the cause of the formation of stones in the urinary tract and consequent renal insufficiency, together with an associated high value for nitrogen in the blood.

Water intoxication must be considered in the contemplation of nephritis and obstruction of the urinary tract. Water intoxication in itself causes symptoms of uremia, restlessness, asthenia, nausea, convulsions, coma, and at times oliguria. If the main channel for the loss of water is closed by renal insufficiency or by obstruction of the urinary tract of any type, increasing the intake of fluids might cause a condition of water intoxication. The continued ingestion of water in an effort to cause diuresis and to reduce the concentration of nitrogen in the blood would only tend to increase the state of water intoxication.

In all cases in which there is even the slightest doubt as to the diagnosis, the patient should be given the benefit of a complete urologic investigation. If this is thoroughly carried out, a small but definite group of patients whose condition has been diagnosed as chronic glomerulonephritis will be found to have conditions that can be partially or completely relieved.

CHARLES G. SUTHERLAND, M.D.

THE UTERUS

Carcinoma of the Cervix Uteri. G. J. Searle. Ohio St. Med. Jour., **35,** 290–293, March, 1939.

The author discusses the general subject of carcinoma of the cervix with more detailed reference to the etiology, pathological classification, and treatment. Beside stressing the well-known hereditary and inflammatory factors in the causation of carcinoma, he emphasizes the recent studies of Kennaway and Cook, in England, in the production of carcinoma in experimental animals by synthetic phenanthrene derivatives. Lacassagne's work, at Pasteur Institute, using estrone (related to the phenanthrene synthetica) as a carcinogenic agent, is also quoted. Relationship between hormonal stimuli to proliferative changes in the cervix, and carcinoma uteri is surmised.

The classification is discussed both in terms of Cutler's microscopical and the League of Nations clinical groupings. In the discussion of x-ray therapy, the following technics are described: the factors used are 220 kv., 8 ma., from 60 to 80 cm. target–skin distance, 2 mm. Cu plus 1 mm. Al or a super-Thoraeus filter. Twice daily a dose of 125 r is given to alternate fields. From six to eight fields are used, two anterior, two posterior, and two ischio-sciatic; the fields are 300 sq. cm. at the start and are reduced to 100 sq. cm. Treatment is continued until each field has received 2,000 r. Larger daily doses may be given to shorten the time for the complete course. The radium technic used includes a 40 mgm. tandem in the cervical canal, and 20 mgm. in a colpostat for a total of 3,500 mgm.-hr. If the carcinoma is limited to the cervix, the radium is used first. In the cases with parametrial involvement, the deep x-ray course is given first. In cases with vesico- or recto-vaginal fistulæ, radium is contraindicated, and x-ray alone should be used. The use of deep x-ray therapy with intravaginal cones with less filtration and higher dosages is described as an alternative technic.

SIMON POLLACK, M.D.

Results of Radiation Therapy of Uterine Carcinoma in the Women's Clinic of the University of Würzburg. R. Schmiemann. Strahlentherapie, **63,** 583, 1938.

This report is based on an analysis of 412 cases of carcinoma of the cervix and 123 cases of carcinoma of the fundus, irradiated during the period from 1924 to 1933. Numerous tables show the results of a detailed statistical analysis. Only 25 per cent of cases of cancer of the cervix, but 75.6 per cent of cases of cancer of the fundus were operable. The percentage of absolute cure amounted to 32.3 for all cases of carcinoma of the cervix; the respective figure for carcinoma of the fundus was 48.8 per cent. Comparing these figures with those published in the world literature, the author comes to the definite conclusion that radiation therapy produces better results in carcinoma of the cervix than operation. As far as carcinoma of the fundus is concerned, he contends that the number of cases analyzed is still too small to offer a definite conclusion. Evidence obtainable so far points to radiation therapy as the more efficient method of treatment.

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